Alberta Forage Manual

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ALBERTA FORAGE MANUAL

Introduction

Before Western Canada was settled, vast areas were covered with grasses. Grasslands serve to protect soil from erosion and at the same time support an enormous animal population. While man has learned to improve on nature, he cannot afford to forget the conservation lessons taught by nature. In today's modern and intensive agriculture, man still depends on forage crops as a means of preventing wind and water erosion, and of building up the tilth and fertility of soils. Canada's last frontier of undeveloped land is made up almost totally of submarginal soil. The improvement of these areas in the decades ahead will be associated with the wise use of forage crops.

This bulletin considers forages as they apply to Alberta. Material is presented to assist the producer in the production and uses of forage. Descriptions and uses of each forage crop are dealt with in greater detail than in previous editions of this publication. Sections dealing with diseases and insects injurious to forage crops have been included because heavy losses do occur in hay and pasture crops. A discussion on soil fertility and fertilization is also included.

HAY AND PASTURE CROPS

Kinds of Forage Crops

Forage crops generally include annual and perennial legumes and grasses consumed by grazing livestock or as stored feed. These species, especially the perennial legumes and grasses, make a valuable contribution towards supplying food and conserving soil and water resources. Forage crops add to the diversity and beauty of agricultural and urban landscapes, contribute to the control of pollution and to the development of recreational facilities.

The choice of species and varieties is one of the most important considerations in growing forage crops. Adaptability and limitations of most forage species and cultivars have been assessed for various regions of the province. Few crops or species exhibit such superior adaptability throughout such a widespread region. Alfalfa is able to grow over a wide range of climatic conditions, primarily because of its great genetic variability. Smooth brome grass also has a wide range of adaptability and can be easily grown with alfalfa. The two species grow at different seasons, thus reducing to some extent the competition for moisture. Crested wheat grass is adapted to areas that are dry to moderately moist and can be grown in most regions. Most other forages have more confined zones of adaptability and should be grown in specific situations.

To obtain a better understanding of the important forage species, details are given on the characteristics, adaptation, limitations, and suitability of most of the common legumes and grasses available in Alberta.

The Legumes

Most legumes grown for forage have tap roots and, in many species, they penetrate deeply into the soil. Various legumes increase in size by growth from the original crown or the formation of new crowns from root portions or rhizomes. However, no legume can increase in stand density to the extent that rhizomatous grasses do.

A most important factor pertaining to legume roots is that they will supply nitrate to the soil if they are properly inoculated with nitrogen-fixing bacteria. This greatly increases the yield potential of legumes and decreases the need for fertilizer.

Legumes are herbaceous plants that have alternate leaves with stipules. The growing points are located at the tops of the plants so that consideration must be given to timing of harvesting, especially by grazing. The leaves are broad and contain high amounts of nutrients. Legumes as a family are very nutritious and make high quality fodder.

The flowers have five more-or-less united sepals and five petals. The upper petal, called the standard, is larger than the others. The two side petals are called wings and the two lower ones are joined together to form the keel. The fruit is a pod, splitting down one or both sides at maturity. Pods may have one or two compartments, or they may be constricted between the seeds.

The main benefit realized from the use of legumes is to increase quality and to supply much needed nitrogen to the soil. Legumes have the potential of producing very high yields, mainly as a result of the added nitrogen. As a group, legumes are well known for their ability to regrow and extend forage growth into late summer and fall.

Alfalfa (Figure 38)

Alfalfa has been called the 'Queen of the Forages' as it is one of the most important forage crops. Introduced to the province of Ontario from France in 1871, it was first grown in Alberta in 1918 when the winter-hardy Grimm strain was grown at Suffield.

Most varieties grown today originated from selections out of common alfalfa, *Medicago sativa* L., or crosses with Siberian alfalfa, *M. falcata* L. Varieties originating from crosses of the two species have been called

variegated alfalfa and are often grouped under the species name *M. media* Pers.

Common alfalfa has a tap root, a narrow crown, fairly wide leaves, and erect stems. The flowers are purple and the seed pods have three to four coils. As it is not winter hardy, a hardier strain of common alfalfa, known as Flemish alfalfa, has been introduced from northern France. Flemish germplasm has been included in several varieties which recover rapidly after cutting, have exceptional vigor, mature early, and are moderately winter hardy. Siberian alfalfa has finer, less upright stems, small narrower leaves, widely branching roots, and a deep-set crown. The flowers are yellow and the pods are sickle-shaped. It is very cold hardy. Variegated alfalfa has a branching root system and, generally, good cold and drought tolerance. The flower color ranges from purple through blue and yellow to white, and the pods have from one-and-a-half to three coils.

Description — Alfalfa has four general types of root system: tap root, branch root, rhizomatous root, and creeping root. A rhizomatous root system enables the plant to spread from the crown by horizontal stems and develops very broad crowns. Creeping rooted plants develop horizontal rootstalks from the main roots. Shoots arising from the rootstalks are capable of becoming independent plants. Rhizomatous and creeping-rooted plants usually are more persistent and tolerate adverse climatic conditions better than tap and branch-rooted plants.

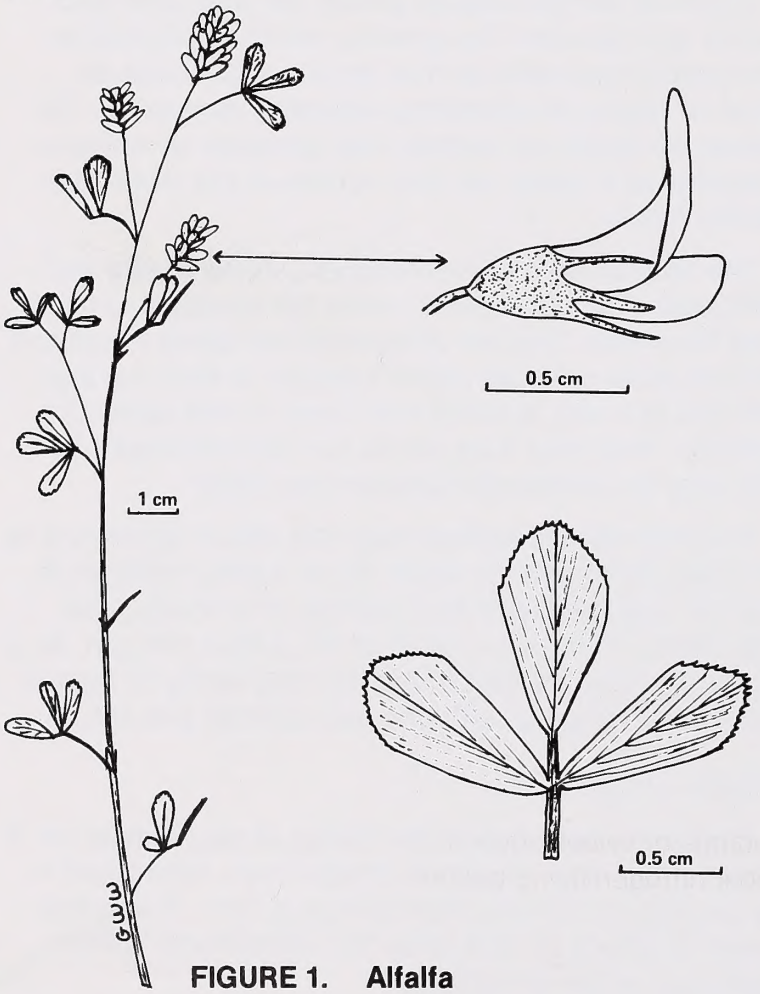

FIGURE 1. Alfalfa

Alfalfa roots grow as deep as 3-5 m in sandy soils with a high water table and, under favorable conditions, may penetrate the soil 7-9 m or more. The ability of the roots to obtain moisture and nutrients from deep in the soil makes alfalfa an especially useful forage crop during periods of drought.

Alfalfa is a medium-lived perennial plant. Although seedlings are not aggressive, the established plants, especially the creeping-rooted types, are very competitive. Hard seeds may be present and scarification is sometimes required for good germination and emergence.

Adaptation — Alfalfa is well adapted to a wide range of climatic and soil conditions, but does best on deep loam soils with a high lime content. It is relatively drought tolerant but, in areas where moisture is deficient, it responds very well to irrigation and produces excellent hay. It tolerates some alkalinity but does not do well on highly alkaline soils. It has a fair salt tolerance.

Limitations — Alfalfa is very sensitive to soil acidity. Growth is best on neutral or slightly alkaline soils and is severely limited below about pH 6.0. The exact level of acidity that alfalfa can tolerate is related to other factors including the level of nutrients, the presence of other minerals such as aluminum and magnesium, and drainage.

It is intolerant of flooding, waterlogging, or poor internal soil drainage during the growing season. Therefore, well drained soils are required for successful alfalfa production. It will withstand short periods of flooding and waterlogging for up to two weeks before growth begins in spring.

The plants are sensitive to depletion of carbohydrates in the roots. Alfalfa should not be cut twice without having an opportunity to store root and crown food reserves during the interval between. If fall use is not correctly timed, the regrowth that occurs will cause a depletion of food reserves. Alfalfa must reach a height of about 25 cm, or the bud stage, to accumulate enough reserves to be vigorous. If regrowth can be utilized late enough in the fall, just before or after killing frosts so that little or no additional growth occurs, the plants will still begin winter with high reserves of carbohydrates. As a rule of thumb, this means alfalfa should not be cut during the four to six week period before the average date of the first killing frost in the fall. In northern Alberta this period extends from early August to mid-September. In central Alberta it extends from August to mid-September, while in southern Alberta it extends from the latter part of August into early October.

Diseases such as winter crown rot, crown bud rot, black stem, leaf spot, and leaf blotch affect vigor and longevity of alfalfa. Bacterial wilt and stem nematodes have been very important particularly in the irrigated areas of Alberta, but they can now be controlled by the use of resistant varieties. Insects that cause considerable damage to alfalfa include the alfalfa weevil, lygus bug, and the pea aphid.

In general, lack of winter hardiness should not be a problem. It is, however, aggravated by poor choice of varieties, drought that dries the soil and plants before winter, warm autumn weather that gives a flush of growth at the expense of root reserves just before freeze-up, low

soil temperatures caused by cold winters or lack of snow cover, surface icing, exceptionally long winters that outlast the dormant period, waterlogged soil conditions, disease, and other factors that decrease vigor.

Use for Hay — Alfalfa is the preferred hay crop in Alberta. It gives a high forage yield with an excellent second cutting. Upright growth and fairly low moisture content make it easy to harvest. Since winter hardiness increases with the ability to become dormant in the fall, the most persistent varieties have the poorest regrowth. As alfalfa is sensitive to depletion of food reserves, late summer and fall cutting must be timed to avoid the so called "critical fall period". Therefore, the variety selected must combine adequate hardiness with the best possible annual yield. In arid areas, it may be practical to select very hardy varieties and harvest one crop whereas in areas with long growing seasons and favorable conditions for winter survival, up to three cuttings may be taken each year. If a suitable variety is selected and is well managed, alfalfa is usually the crop that will yield the greatest quantity of high quality forage in Alberta.

Use for Pasture — Alfalfa is quite palatable and withstands grazing fairly well provided it is not overgrazed. It regrows well throughout the season. Despite the availability of bloat-free legumes, it is still the most used pasture legume in Alberta because of its good yield and fair persistence. It should not be grazed closer than 10-15 cm. Varieties with creeping roots generally withstand grazing pressure better than others. Fall grazing must be timed to avoid leaving the plants low on energy reserves when winter begins. After killing frosts have ended the growing season, the remaining forage may be grazed, although some stubble helps to trap snow to insulate against low winter soil temperatures and frost heaving.

Bloat may be a problem. By including at least half grass in the pasture mixture the risk of bloat is greatly decreased. The bloat hazard is diminished if grazing is delayed until after the bloom stage. Adhering to these and other bloat reduction procedures should make the inclusion of alfalfa in pastures practical even on farms that have had serious losses.

Sweet-Clover (Figure 39)

Sweet-clover is an introduced species that was reported growing in North America as early as 1739. Since 1875, it has been recognized as a valuable forage crop. It is a fast-growing legume that is valuable for soil improvement, hay and silage production, and nutritious pasturage. It is an excellent source of nectar and pollen for honey bees and produces high quality honey.

The sweet-clover grown in Alberta is a biennial plant. Growth in the first season consists of one central, much branched stem. Toward the end of the first year, several buds form at the crown, usually just below the ground surface. In the spring of the second year, the crown buds start growth quickly with vigorous, rapidly growing stems that are much taller and coarser than in alfalfa.

There are two common types of sweet-clover, white-flowered and yellow-flowered. The white-flowered sweet-clover, *Melilotus alba* Desr., is taller, coarser stemmed and has coarser leaves than the yellow-flowered type, *M. officinalis* L. Yellow sweet-clover is more drought tolerant, more vigorous as a seedling, flowers earlier, and has spreading growth and purple flecks on the seed coat.

Description — Sweet-clover is one of the best legumes for soil improvement as it thrives under a wide range of soil and climate conditions. Its deeply penetrating, strong tap root opens up the subsoil, increasing aeration and providing conditions favorable for the growth of succeeding crops. The high yields of roots provide large amounts of nitrogen as the roots break down and decay rapidly at maturity.

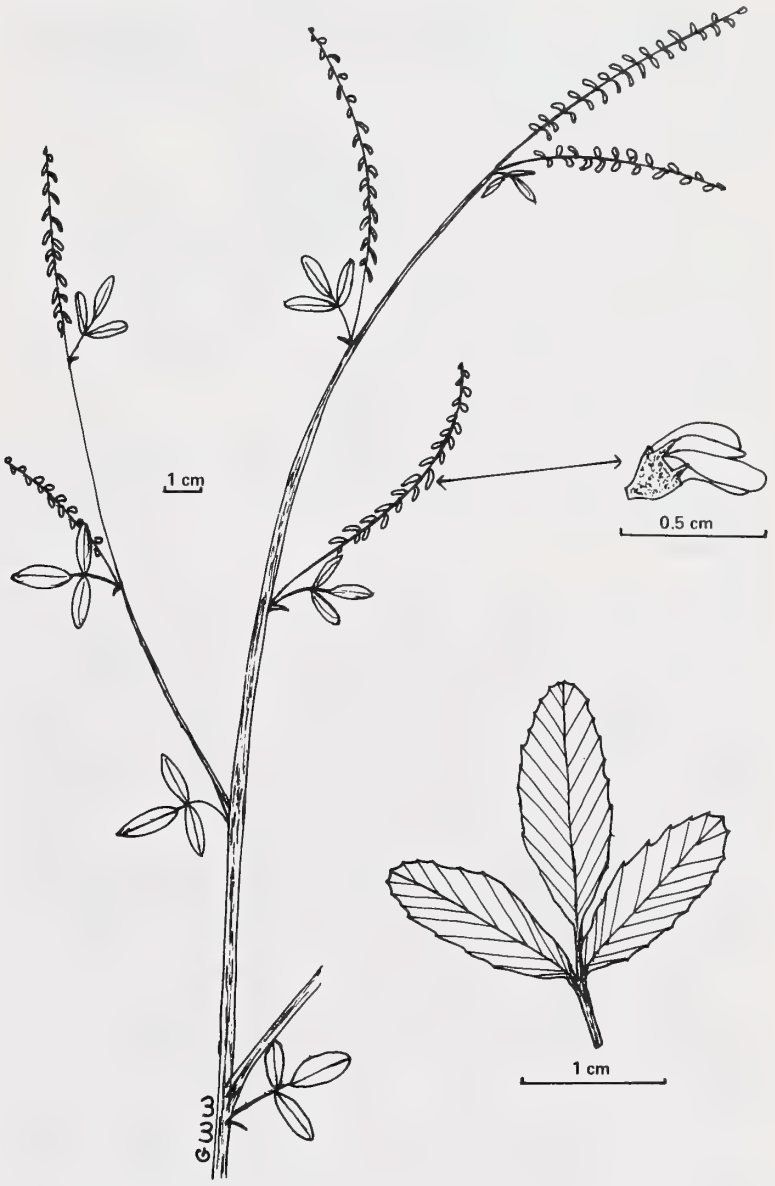

FIGURE 2. Sweet-clover

Seeds of sweet-clover have a hard seed coat and should be scarified before seeding. Seed companies sell only scarified seed. Some seeds may remain in the soil for one to many years before germinating, so volunteer plants often develop on land sown originally to sweet-clover. New seedings of sweet-clover should be inoculated with the proper nitrogen-fixing bacteria.

Adaptation — Sweet-clover is winter hardy and productive, especially on fertile, well drained clay and clay-loam soils. It can also be grown successfully on sandy loams and heavy clay loams as well as on Gray Luvisol soils. It grows best on neutral or alkaline soils, and is one of the best legumes to grow on highly alkaline soils. Sweet-clover can also be used in the revegetation of

mechanically disturbed soil sites, but it should not be sown on land that is subject to flooding or on acid soils.

Sweet-clover is drought resistant and is particularly well adapted to the drier areas.

Limitations — Like alfalfa, it is very sensitive to acid soils and growth is severely limited below about pH 6.0.

Although it tolerates a few days of flooding before growth begins in spring, it cannot endure flooding during the growing season. Like alfalfa, it is intolerant of water-logged soil or poor internal soil drainage.

The high coumarin content of sweet-clover makes it less palatable to livestock than many other legumes. However, low-coumarin varieties are now available.

Sweet-clover plants decline in quality as they reach maturity and become woody and stemmy.

Sweet-clover weevils frequently damage seedlings and, in dry years, they can prevent establishment of the crop. Since infestation occurs from established stands, new seedings should be made as far from them as possible. Occasional damage to seedling stands may also occur from cutworms and grasshoppers.

Since sweet-clover is very subject to injury from herbicides, particularly 2,4-D, weed control during the establishment year is more difficult than with other legumes.

Use for Hay — Sweet-clover gives a high yield of hay, but it is difficult to harvest. Quality is high if the crop is cut in the bud stage. Delaying cutting until full bloom results in stemmy, low quality hay since the large, moist stems take longer to dry than the leaves, which become brittle and shatter badly. Coumarin, which gives this forage a sweet aroma, develops into dicoumarol, a potent anticoagulant, under poor curing conditions. This chemical causes 'sweet-clover disease' in livestock in which the blood loses its normal ability to clot and death results from internal bleeding or minor injuries.

Although most sweet-clover hay is safe for feed, improperly cured or moldy forage should be used with caution. Samples from such forage should be sent to a feed testing laboratory for a chemical analysis of dicoumarol content. The danger of losing animals from bleeding can be lessened by feeding sweet-clover for two weeks, followed by two weeks of feeding other forage. Spoiled sweet-clover should be disposed of and not fed to animals.

As with seedlings, regrowth after hay cutting must come from stem buds. Therefore, hay should be cut at least 30 cm high if second growth is desired.

Use for Pasture — Sweet-clover, particularly white sweet-clover, produces good pasture yield. Growth begins early in spring with rapid production in June and July. A height of about 30 cm should be maintained throughout the summer to allow for rapid regrowth and good quality. This height is desirable in order to allow some green leaves to synthesize carbohydrates, while allowing light to get into the base of the stems so that active buds remain alive to recover growth. It is also necessary to prevent the forage from becoming tall and woody.

When growth has stopped in late autumn, seedling stands may be grazed without affecting yield the next year. Regrowth after hay harvesting can also be utilized by livestock.

Bloat can be a problem when grazing sweet-clover, although it is less common than with alfalfa or true clovers. Scouring may also occur, especially when growth is young and succulent. If the animals have access to dry roughage, both conditions will be reduced.

Alsike Clover (Figure 40)

Alsike clover, *Trifolium hybridum* L., was cultivated in Sweden as early as 1750 and was introduced into North America in about 1834. It became an important legume in the clover-timothy growing areas. It was introduced into northern Alberta as a seed crop in about 1932.

Varieties of alsike clover grown in Canada are either of a diploid (2n = 16) or tetraploid (2n = 32) type. The common type grown is diploid. Tetraploids, with double the number of chromosomes, are taller, have larger leaves and flowers, and are later maturing than the diploids. In some areas, the forage yields of tetraploids are higher than of diploids.

Description — Alsike clover is a short-lived perennial but it is often used as a biennial. Tillers grow profusely from the crown with stems at least as long as those of red clover, but more slender and prostrate. Stems and leaves are smooth. The pink or white flower heads are somewhat smaller than red clover heads. Alsike clover continues to bloom throughout the season. The stem bears flowers along its entire length, the oldest below and the youngest at the top of the stem. This characteristic is important not only from the standpoint of seed production, but also in making alsike clover suitable for hay over a longer period than red clover.

FIGURE 3. Alsike clover

The root system penetrates deeply into the subsoil. The roots have many branches but are noncreeping. Root pieces that survive frost heaving can produce new plants. Under favorable conditions, alsike clover may spread, especially if seed is harvested or mature alsike clover hay is fed to animals.

Adaptation — This cool season crop is adapted to low-lying moist areas. It will tolerate soils that are completely waterlogged and withstands spring flooding up to six weeks. It is also well suited to acidic organic soils and thrives on Gray Luvisol soils and heavy moist alkaline soils. Alsike clover tolerates more alkalinity than most other clovers. It is easily established where there is minimal land preparation, but must be seeded shallowly. Of our legumes, it is the most tolerant of cold and frost heaving. Damage from insects and diseases and depletion of root carbohydrates are uncommon, so that it has excellent winter hardiness.

Limitations — Alsike clover is intolerant of drought and high temperatures. It will not survive on land that floods in spring, but dries up in the heat of summer. Salinity tolerance is also low, so this legume will not grow well around saline sloughs of central Alberta.

Shade tolerance is poor which makes it less useful for mixtures with tall growing grasses such as reed canary grass.

Use for Hay — In the moister areas of Alberta, alsike clover yields well and generally will thrive where other legumes fail. Like red clover, it is high in moisture content and, therefore, is difficult to cure in the field; however, it retains its green color somewhat better. Alsike clover is seldom grown alone, but it produces good yields in mixtures with grasses such as timothy, and since the grass holds the clover more upright, harvesting is easier. Normally, only one cutting can be harvested for hay each season.

Use for Pasture — Regrowth after hay cutting is quite good and is similar to that of single-cut red clover. Alsike clover is very palatable to cattle. Proper fall use will not deplete root carbohydrates or affect winter hardiness.

Alsike clover is satisfactory in a pasture mixture, although its short life limits its usefulness to the first few years of production. It is somewhat difficult to control the proportion of alsike clover in a mixture since this legume tends to dominate the stand for the first one or two years and then it decreases rapidly.

The bloat hazard is similar to that of red clover or alfalfa.

Red Clover (Figure 41)

Red clover, *Trifolium pratense* L., native to most of Europe and portions of Asia, was introduced into this country over 200 years ago. It is widely adaptable and can be grown with grasses and other legumes for hay, pasture, and silage in short-term rotations.

Two types of red clover are grown in Alberta. The most commonly grown are single-cut varieties, also known as mammoth or late-flowering red clover which produces one good crop of hay and enough regrowth for excellent fall pasture. The double-cut varieties, also known as early flowering red clover, can be cut earlier than the single-cut types and, because they recover quickly, can produce a good second crop. This type, however, is not as hardy or persistent as the single-cut type.

Most of the common varieties of red clover are diploid (2n = 14). The tetraploids (2n = 28) may be of the early flowering double-cut or late flowering single-cut types. Tetraploids usually have coarser stems, larger leaves, larger flowers, and slightly larger seed.

Description — Red clover is a short-lived perennial. Good stands persist for two to three years depending on the variety, type, soil, and climate. The hairy and leafy stems arise from the crown.

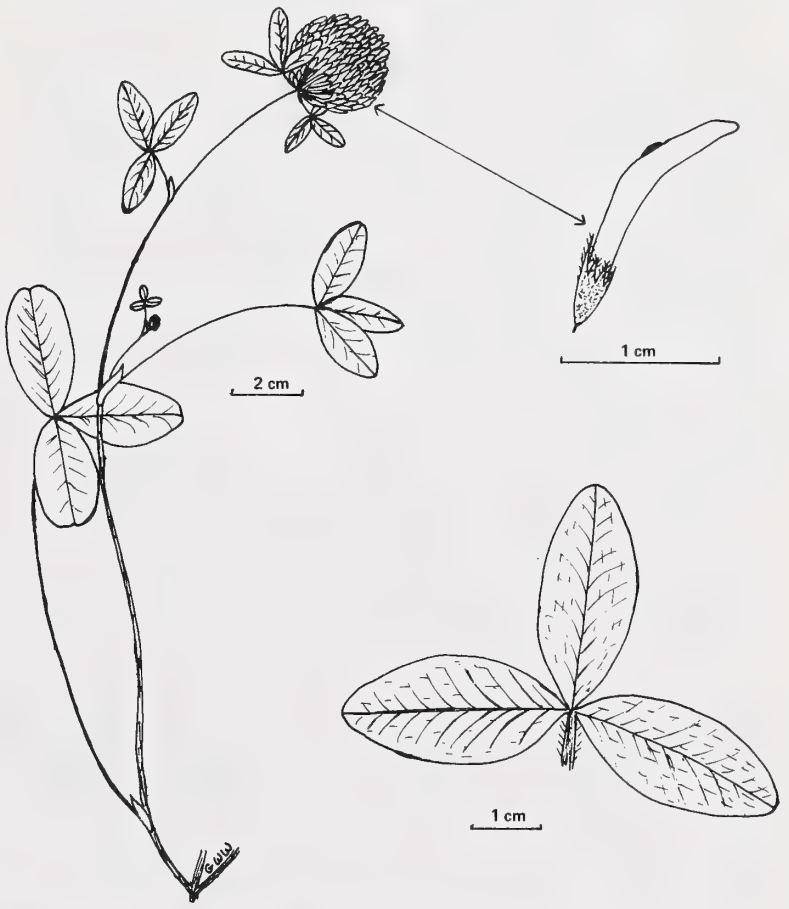

FIGURE 4. Red clover

Each leaf is divided into three oblong leaflets, with a halo or light-colored marking in the centre of each leaflet. Flower color usually is rose purple, or magenta. The plant has a tap root with many side branches, but the roots do not penetrate the soil as deeply as those of alfalfa. It establishes itself very readily as the seedlings are very vigorous.

Adaptation — Red clover is adapted to a wide range of soil types, but it is best suited to humid areas with moderate temperatures. It is recommended for use in the semi-moist and moist areas of the Gray Luvisol and the Black soil zones. It is more tolerant of acid soils than alfalfa, alsike clover, or sweet clover but yields are reduced if soil pH is less than 5.0. It is not as well adapted as alsike clover to low, poorly drained soils. Red clover is quite cold tolerant.

Limitations — Being short lived, single-cut red clover varieties do not constitute a major portion of a stand for

more than three years. Double-cut varieties remain productive for only one, or at most two years when grown under favorable conditions.

Although red clover has a low tolerance to flooding and waterlogging, it is more tolerant of poor drainage than alfalfa and sweet-clover, and will survive two weeks of spring flooding. Red clover is intolerant of salinity or lengthy periods of drought.

The small seed should be sown at a shallow depth.

Diseases such as crown and root rots, northern anthracnose, black stem, and powdery mildew decrease yield and frequently contribute to winter kill by reducing vigor. Snow mold may also cause winter kill. Harmful insects include grasshoppers, leaf hoppers, root borers, lygus bugs, thrips, clover seed chalcids, and clover seed midge.

Use for Hay — In the moister areas of Alberta, red clover frequently gives the highest yield of all forages. Single-cut varieties are usually harvested at a more mature stage to obtain highest yields, but a lower percentage of protein and energy. Although double-cut varieties have not been used much because of short life span, they can produce large quantities of excellent quality hay when two cuttings are harvested. Areas that are unsuitable for alfalfa may be able to make use of double-cut red clover in short rotations.

Because it is very high in moisture content, gives a high yield, and is adapted to moist areas, it is a difficult forage to dry for hay. Preservation of green color is more difficult than with other legumes so that hay often appears to be of poorer quality than it is. Red clover grows very well with timothy and this also makes for easier harvesting. It gives a full yield in the first utilization year.

Use for Pasture — Even single-cut varieties regrow well after haying and make very palatable fall pasture. Also, fall grazing is not likely to deplete root carbohydrates. Red clover is satisfactory in a pasture mixture although its short life limits its usefulness to the first two to three years of production and it tends to dominate the stand initially.

The bloat hazard is almost as great as with alfalfa and normal precautions should be taken where there is history of bloat.

White Clover (Figure 42)

White clover, *Trifolium repens* L., was apparently well established in North America by 1750 after it was introduced by the first settlers from Europe. It is the most widespread legume known as it is found from the Arctic circle to the temperate regions of the world.

Three types of white clover are grown in Alberta. They are: ladino, or large white clover; white Dutch, or intermediate or common white clover; and the wild type, also known as low growing or small white clover. The ladino type grows two to four times taller than white Dutch and is therefore much higher yielding. It is less winter hardy, less resistant to very low clipping, and less likely to flower well, especially in cloudy, moist climates. The ladino types persist and grow longer during the heat of the summer. White Dutch clover is quite variable and sometimes approaches the tallness of the ladino type or it may be as small as the wild white clover. Usually, white Dutch clover is intermediate in size. Both white Dutch clover and wild white clover are low growing and, therefore, persist only where taller growing species are absent. All three types are closely related and cross pollinate.

Description — White clover is a short- to long-lived perennial. It has a shallow tap root which may grow to a depth of at least 1 m and has very small crowns. It produces above-ground creeping stems called stolons that root at the nodes, thus permitting individual plants to spread over a considerable area. The plant has no upright stems as the top growth consists of leaf stems or petioles and leaves. There is usually a V-shaped white mark in the middle of each leaflet. The taller growing flowers are

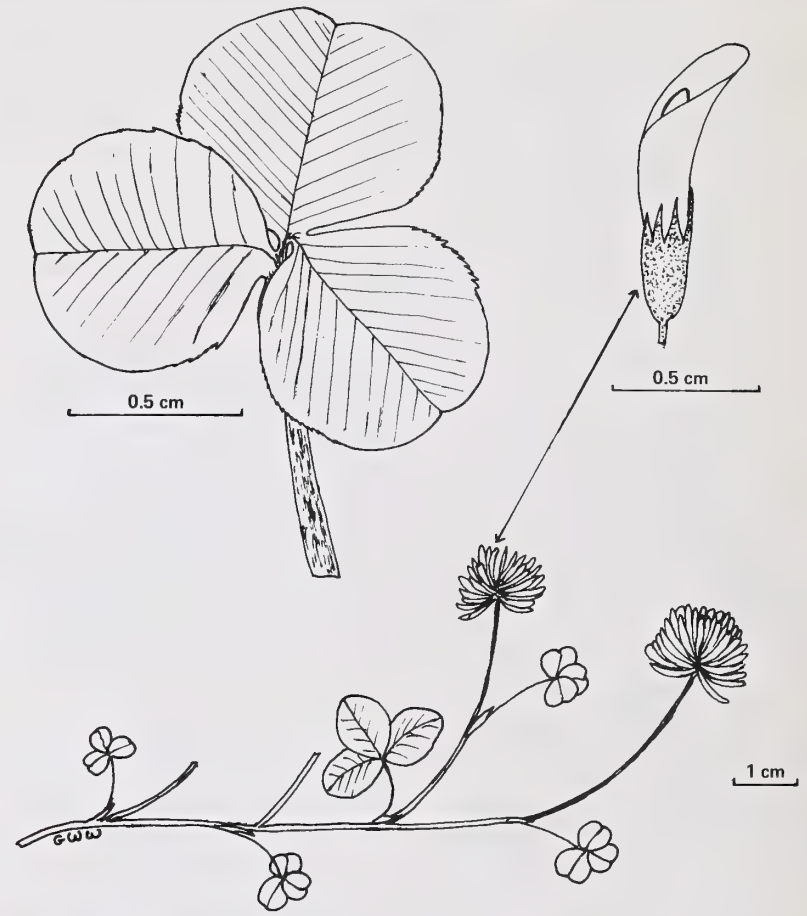

FIGURE 5. White clover

predominantly white, as the common name of the species suggests, but are sometimes tinged with pink. The small yellow seeds have a hard seed coat that permits germination many years after the initial seeding. The hard seed of white clover may pass intact through the digestive track of grazing animals, thus allowing reseeding and spread of the species.

Adaptation — White clover is best adapted to well drained silt loam and clay soils that have a fairly constant supply of moisture. It can be grown on sandy soils with adequate moisture and fertility. It will tolerate slightly acidic soils, but is not tolerant of saline or alkaline soils. It grows best during cool, moist seasons or in areas where irrigation is possible.

Although white clover is moderately winter hardy, it can persist for long periods through natural reseeding or

through the rooting of young stolen ends.

Limitations — White clover has a low tolerance to drought because of its shallow root system. Since periods of high temperature are also unfavorable for growth, a prolonged drought can kill a stand. It is also intolerant of prolonged flooding and does poorly on a waterlogged soil.

Lack of winter hardiness limits the use of ladino types to the irrigated areas of Alberta. White Dutch clover persists for a few years in the more moist parts of the province, but wild white clover is most persistent. Although it is less sensitive to fall grazing than alfalfa, it should not be grazed in early fall in order to allow it time to prepare for winter.

Use for Hay — The ladino type is the only white clover that grows tall enough to be useful in a hay mixture. It does satisfactorily in a red clover-timothy mixture provided hay is harvested early to eliminate the shading from these tall-growing forages. Since no stems are harvested, the leaves and petioles make hay that is very high in protein and digestibility.

Use for Pasture — Ladino white clover is most useful as a pasture species. The low-growing habit of white Dutch and wild white clover make them useful only as pasture. All types are palatable and very nutritious since livestock only consume leaves, petioles, and flower shoots. White clover begins growth fairly early in spring, but does not do well during the heat of the summer. It regrows rapidly after grazing. Bloat occurs about as frequently as with red and alsike clover.

Ladino types are fairly long-lived and yield very well in irrigated areas. They should be about 20 cm tall before grazing. The closeness of grazing depends on the grasses in the mixture. With tall-growing species, such as timothy or brome, clipping should not be closer than about 8 cm. With orchardgrass, which regrows very rapidly, grazing height should be reduced to about 5 cm to allow the clover to persist in the stand.

White Dutch clover is sometimes seeded in pasture mixtures in moist areas of Alberta. Although it tolerates close grazing, it is not persistent and usually kills out in two to three years. Where wild white clover is present, it will come in when the white Dutch dies.

In western Alberta, wild white clover and native bluegrass or creeping red fescue will provide permanent pastures of medium yield where cultivation is impractical. Early and fairly close grazing is recommended. Although wild white clover persists and provides some pasture under conditions of extreme overgrazing, its presence in pastures is an indication that heavy stocking rates are decreasing total yield. No other legume will tolerate the heavy and continuous grazing that wild white clover will, so it often dominates the stand after higher yielding forages have been grazed out.

Bird's-Foot Trefoil (Figure 43)

Bird's-foot trefoil, *Lotus corniculatus* L., is native to Europe and parts of Asia. It was first reported growing in North America in 1934 and has now become a valuable forage crop. It is important as a pasture legume in Ontario because of its ability to survive on less fertile soils and soils having poor internal drainage where alfalfa does poorly.

It has been grown in Alberta. Although most plantings have been productive for only two or three years, some have been very successful and productive.

There are two types of bird's-foot trefoil: The empire type and the common or European type. The empire type is semi-erect, fine stemmed, and flowers 10-14 days later than the European type. The European types have earlier spring growth, erect growth habit, and more rapid seedling and recovery growth than the empire type. The empire type, however, is the most winter hardy and is commonly grown.

Description — Bird's-foot trefoil is a potentially long-lived perennial forage. It has small weak roots as a seedling, but a strong deep tap root system with many side branches when mature. It can form new crowns and roots from root portions that survive frost heaving. It has many fine stems, but is not as tall or as upright growing

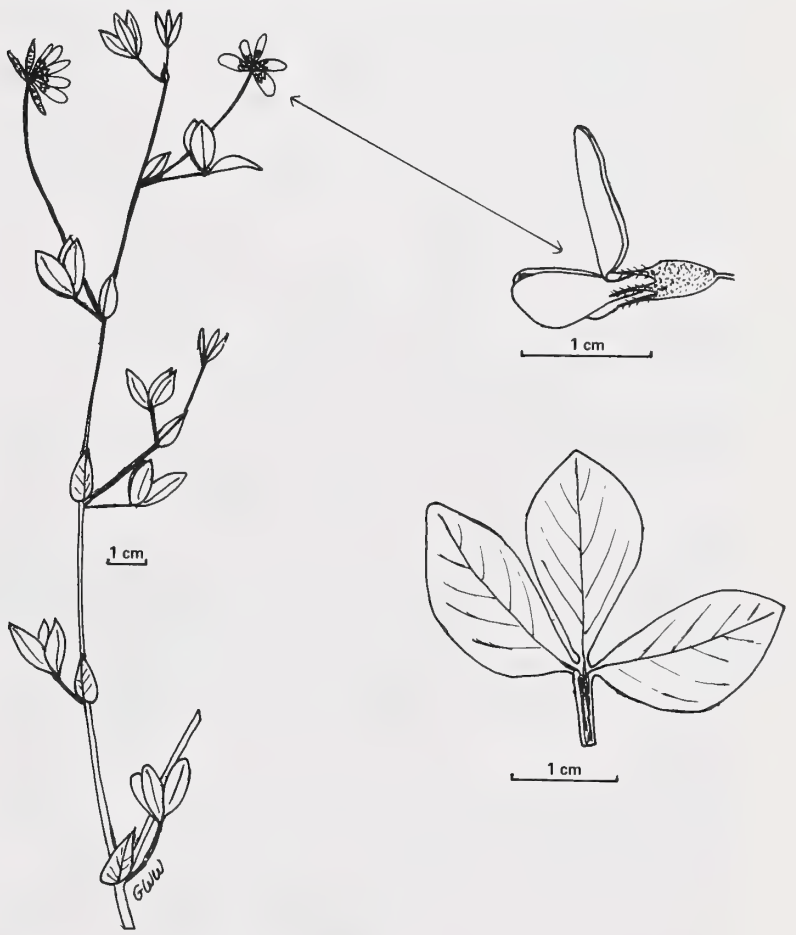

FIGURE 6. Bird's-foot trefoil

as alfalfa. Two large stipules make it appear to have five leaflets. Blossoms are bright yellow or orange, and several seed pods are attached at a single point giving the appearance of the toes of a bird's foot. It will reseed itself even if closely grazed as it often flowers and sets seed on stems near the ground.

Adaptation — Bird's-foot trefoil is very tolerant of water-logged soils and withstands several weeks of flooding and some acidity. Since it is also more tolerant of low fertility than alfalfa, it may be useful in some organic soil areas.

Bird's-foot trefoil withstands high alkalinity and some salinity as well. Although it is not adapted to dryland

areas, it may be useful in some low-lying areas of central Alberta that flood in spring but become dry during summer. It grows best in the Gray Luvisol and Black soil zones.

Limitations — Stand persistence is a major problem. This may be related to a number of factors. Although good yields have been produced the first utilization year in more moist areas, it is reported to require two years to become well established. Therefore, it should be used lightly in the first utilization year. Like alfalfa, it is subject to depletion of root food reserves in autumn and this aggravates its lack of winter hardiness. Also, it is intolerant of competition from other plants, particularly tall ones that shade it, such as smooth brome grass and timothy. This is such a great problem during establishment that nurse crops should be avoided and weeds must be controlled. It grows best alone rather than in mixtures although simple mixtures with nonaggressive grasses have shown promise in some cases. It should not be seeded where aggressive perennial weeds such as quackgrass or Canada thistle are present.

Seeds are very small and will not emerge if seeded too deeply. A firm seedbed and very shallow setting, 5-10 mm are especially important. Bird's-foot trefoil must be inoculated with a specific *Rhizobium* species for nitrogen fixation to occur. This is particularly important since soil that has not grown bird's-foot trefoil is sure to lack the correct *Rhizobium* species.

Use for Hay — Bird's-foot trefoil is well suited to hay harvesting although only one cutting can be obtained. It generally yields about two-thirds as much as alfalfa. It contains a fairly high amount of water and is more difficult to dry than alfalfa. Hay quality is comparable to that of alfalfa. Because heavy crops lodge, cutting them is more difficult and a lodged crop will kill out if not harvested soon after falling.

Use for Pasture — Bird's-foot trefoil withstands grazing better than most other legumes. Bloat is no problem and palatability is fairly high so that good livestock control is necessary to prevent overgrazing. Production is well distributed throughout the grazing season, but four to six weeks are required to obtain a regrowth of 15-25 cm between grazings. Regrowth after haying can be pastured but grazing must be timed to avoid root food depletion before winter. Bird's-foot trefoil has the potential to provide productive and nutritious pasture for many years in the areas for which it is adapted.

Sainfoin (Figure 44)

Sainfoin, *Onobrychis viciaefolia* Scop., has been cultivated in parts of Europe and Asia for over 400 years. It did not create much interest here as most of the strains introduced into North America were low yielding and poorly adapted to our conditions. However, recent introductions have resulted in the release of improved varieties that are adapted to many of the areas where alfalfa can be grown.

Especially well adapted to dry calcareous soils, it is long-lived on dryland but short-lived on irrigated land. Sainfoin does not induce bloat in grazing animals. It is immune to the alfalfa weevil and could be used as an alternative to alfalfa in areas where the weevil is a problem. Honey bees will pollinate sainfoin and produce excellent quality honey.

Description — Sainfoin is a potentially long-lived perennial forage. It grows to a height of 1 m or more, and is usually taller than alfalfa. It has deep tap roots with many side branches. The upright stems are hollow and coarse but very succulent. Leaves are divided into many leaflets. The large rosy pink flowers appear on spike-like heads one or two weeks before alfalfa blossoms and

FIGURE 7. Sainfoin

are characteristic of the crop. The pods contain single seeds and shatter as they mature. The seeds are large, averaging about 3 mm in length. Although the seed is large, sainfoin does not emerge well from deep plantings.

Adaptation — Sainfoin is more drought and cold tolerant than alfalfa, but thrives where alfalfa grows well. It is best adapted to Brown and Dark Brown soil areas and grows on soils high in alkalinity. In very dry areas it survives but yields poorly. It does well on thin, gravelly soils.

Sainfoin is not recommended in areas where annual precipitation is less than 300 mm. It responds to irrigation but does not need irrigating as frequently as alfalfa.

Sainfoin begins growth early in spring and is very tolerant of early spring frost. Established plants are able to make excellent use of available moisture in the spring.

Insect and disease problems are uncommon. Although it is immune to the alfalfa weevil, damage by the sweet-clover weevil has been known to occur.

Limitations — Sainfoin requires good drainage and has a low tolerance to flooding, waterlogging, or even high water tables. It is intolerant of acidity and salinity.

This crop is generally less hardy than adapted varieties of alfalfa. It tends to be short-lived and, depending on adaptability to a given site, it may yield well for one or more production years. Although it is easy to establish, the seedlings lack competitive ability. The vigor of the plants is decreased by clipping during the seedling year. Nitrogen-fixing bacteria have been short-lived or ineffective so that nitrogen fertilization may be required. Productive life may also be related to such factors as clipping height and frequency, and competition from other forages and weeds in an established stand.

Use for Hay — Sainfoin is well suited to hay harvesting as it grows upright and is easily cut. Although it is somewhat higher in moisture content than alfalfa, it does not present the problems in curing that red clover and alsike clover do. Since regrowth is very poor, it is best suited to taking one clipping at about the half- to full-bloom stage. Unlike alfalfa, it does not drop its lower leaves; stems remain succulent as the plant matures so that quality does not decrease so rapidly. Yield is often better than that of alfalfa for one clipping, but only 80-90% as high when two cuttings per season are compared. It competes poorly in mixtures with aggressive grasses and, although total yield is usually not affected, the proportion of sainfoin decreases. It is usually seeded alone, especially under irrigation.

Use for Pasture — The advantages of sainfoin for pasture use include excellent quality and palatability that give superior animal performance without the danger of bloat. Compared with orchard grass in irrigated areas, it yields about one-third less, regrows more slowly after grazing, and has a shorter productive life. However, grazing in the bud or early bloom stage and keeping the grazing height above about 20 cm will lengthen productive life from two to three to about six years in irrigated areas.

It is adapted to dryland pastures as well and grows satisfactorily in mixtures with bunch grasses such as Russian wild rye or crested wheat grass. However, total yields are slightly higher when sainfoin is grown alone.

Sainfoin is a very early growing legume and it may tolerate light grazing during the bud stage and still yield a good crop of hay. Residual yield after hay cutting may be grazed, but once this species reaches full bloom regrowth is very poor.

Cicer Milk-Vetch (Figure 45)

Cicer milk-vetch, *Astragalus cicer* L., is a native of Europe, where it is found in cool, moist locations along streams and ditches, in open woodland, and on flood plains. It was first introduced to the U.S.A. from Sweden in 1926 and to Canada from the U.S.S.R. in 1931. The Canadian introduction was tested in nursery rows, but it attracted little interest until recently because of the difficulty of establishing stands.

The potential of the legume was realized when plants of cicer milk-vetch were found to invade established stands of timothy in the foothills area. Further studies indicated that this new forage legume has many advantages when considered for pasture use.

Description — Cicer milk-vetch has a vigorous, deep root system that may expand its diameter to as much as 120 cm under favorable conditions. It is a very long-lived perennial. Stems are hollow and succulent. Growth is upright when plants are young, but stems tend to bend over as additional growth occurs. Height seldom exceeds 60 cm even though stems may be 120 cm long. Leaves are

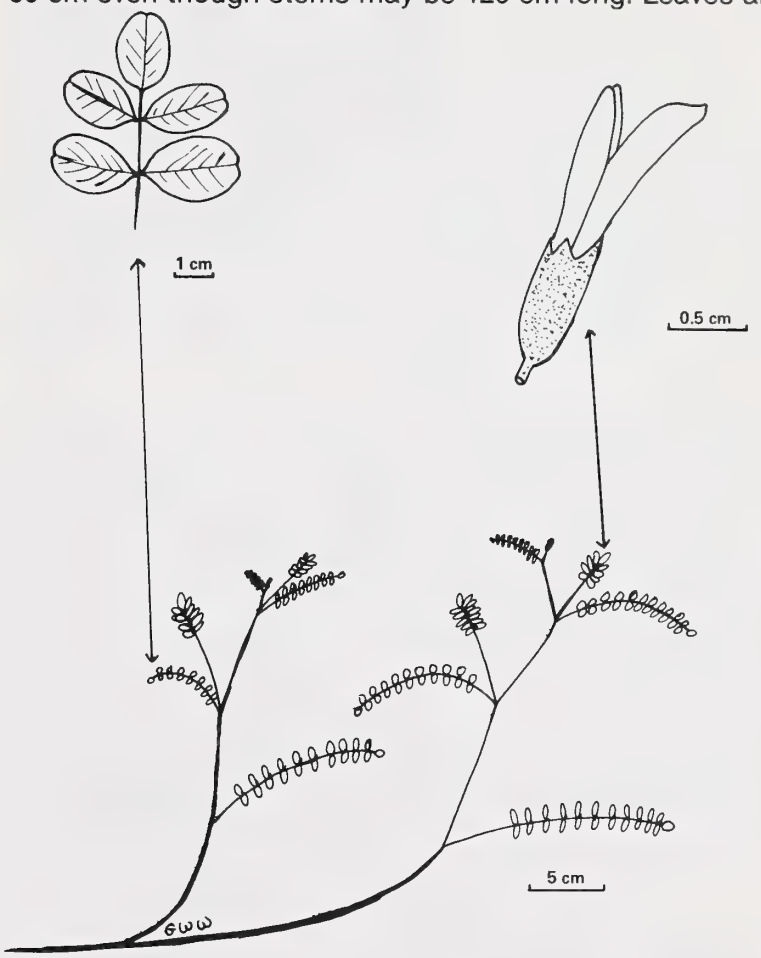

FIGURE 8. Cicer milk-vetch

divided into many leaflets. Flowers are pale yellow to white, initially green to red-green pods become black and leathery as the seeds mature. The flattened seeds are about twice as large as alfalfa seeds and are very hard.

Adaptation — Cicer milk-vetch is adapted to soils with medium to high amounts of moisture. It will not stand flooding, but is adapted to soils with a high water table. Drought tolerance is fairly good although yield is reduced.

It is adapted to a wide range of soil textures, but exhibits its creeping habit best on more coarse textured soils. This forage crop has been grown very successfully on Black soils in southwestern Alberta. However, its range of adaptation includes the more moist areas in the Dark Brown soils and Gray Luvisol soils.

Cicer milk-vetch is very hardy and more tolerant of cold and frost heaving than alfalfa. Once established, it is very aggressive and grows well until the end of the season. It is quite tolerant to alkalinity and is moderately tolerant to acidity and salinity. Disease problems are uncommon, although root, crown, and stem rots do occur. Snow mold does little damage. Insect damage is usually light although aphids, thrips, sweetclover weevils, and grasshoppers do feed on it.

Limitations — Hard seed is common and percent germination will not be adequate unless seed is scarified. Cicer milk-vetch seedlings are weak and slow to establish. The use of nurse crops should be avoided. Two seasons are frequently required for this legume to become established. As this appears to be its major drawback, seedbed preparation, seed placement, and weed control are all very important.

Although cicer milk-vetch appears adapted to high levels of soil moisture, it requires good surface drainage.

Established stands of this legume are very late to begin growth in spring, generally about three weeks after alfalfa.

Use for Hay — Although cicer milk-vetch is easily harvested for hay, it yields typically about 20% less than alfalfa. In one trial in southwestern Alberta, it outyielded alfalfa because of its resistance to pocket gopher damage. Leaf losses during harvesting are low and the nutritive quality is equal to alfalfa in early bloom and does not decrease as rapidly as the plant matures.

Use for Pasture — Cicer milk-vetch may be the legume that could provide good forage yields and high levels of fixed nitrogen for long-term pastures. It is long lived and very tolerant of grazing. Although it begins growth late in spring, the growth is well distributed throughout the season. Production is very good in late summer when most other pasture plants grow slowly. It does not induce bloat in grazing animals and does not accumulate selenium.

Cicer milk-vetch appears to grow well with most grasses, especially bunch-type grasses. After grazing regrowth is slow so that a longer rest period between grazings is necessary.

Crown-Vetch

Crown-vetch, *Coronilla varia* L., is most widely distributed in southern Europe and in the eastern Mediterranean area. It has been used as an ornamental for many years and was commercially available in the U.S.A. by 1890. The interest in crown-vetch began with a single plant that appeared some time between 1905 and 1910 on a Pennsylvania farm and persisted through successive crops, finally spreading into a permanent pasture. The exceptional vigor of this strain, its extreme drought and cold tolerance, its almost complete freedom from disease, and its excellent performance resulted in its release as a variety.

Crown-vetch can be used for pasture, but its use is normally limited to soil improvement, erosion control, etc. Its perennial habit, together with its ability to produce a dense protective surface cover and a deep, heavy root system on poor soils, make it an ideal plant for use as ground cover for highway embankments, mine spoil areas, and other disturbed environments.

Description — Crown-vetch, a perennial, derives its common name from its vetch-like leaves and the arrangement of its flowers in the head resembling a crown. It produces a deep and many-branched tap root and numerous fleshy creeping roots that may develop to a length of 3 m or more. Thus, a single-parent plant may fully occupy an area of about 9 m² within a period of three

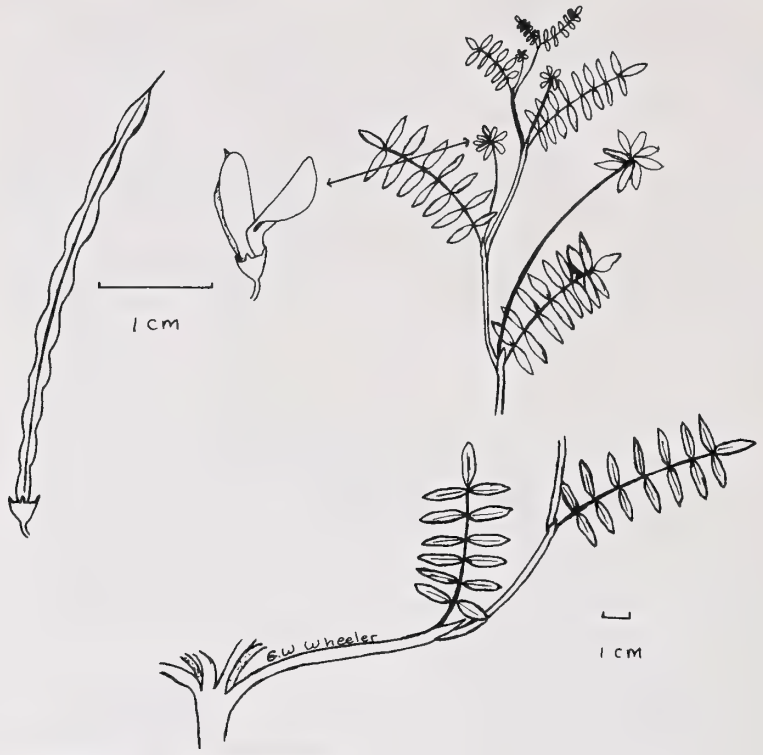

FIGURE 9. Crown-vetch

to four years. The flowers, a variegated white to purple color, are on stems from 30-120 cm long. The seeds are borne in long, jointed pods that may contain three to ten or more rod-shaped seeds.

Adaptation — Crown-vetch is best adapted to fertile, well-drained soils of pH 6 or above. It has been established on soils with severe erosive characteristics and on poorly drained soils that have a tendency to slide.

Seed is normally used in establishing crown-vetch, but excellent results have been obtained by planting crowns.

Limitations — The greatest weakness of crown-vetch is its slowness to establish an adequate protective cover. it is very slow in germination and seedling growth when compared to alfalfa. A high percentage of crown-vetch seeds have hard seed coats and will not germinate for one to two years after planting. Major problems associated with the crop include seed production, stand establishment, and forage utilization. It is generally not winter hardy.

The seed must be scarified and inoculated with the proper rhizobia before planting.

Use for Hay — Crown-vetch is better suited for pasture than for hay because of its indeterminate growth habit. Crown-vetch hay contains nitro-compounds that could be toxic to nonruminants, but can be safely fed to ruminants.

Use for Pasture — Crown-vetch is unpalatable to cattle in early spring when initially grazed. Sheep tend to consume leaves and avoid stems.

Crown-vetch appears to be somewhat less sensitive to mid-summer stress than other legumes and provides a better seasonal distribution of available forage. However, crown-vetch stands deteriorate after three seasons of continuous grazing.

The Grasses

Grass species have many advantages. The root systems of grasses are fibrous. This makes them excellent soil binders. Some grasses also have underground stems (i.e. rhizomes) which produce new shoots at each node (i.e. joint). Rhizomatous grasses thicken quickly in a stand forming a dense, firm sod that competes very strongly for nutrients. Grasses which do not have rhizomes are said to have a bunch habit of growth. Bunch grasses do not form a thick stand (although individual plants become larger with more stems) and are not as competitive. This decreased competitiveness makes them more suitable for mixtures with legumes. When seeded in widespaced alternate rows they will not crowd out legumes in the mixture. In the drier parts of Alberta, such as the Brown soil zone, wide-spaced rows of 45-90 cm have been shown to utilize total moisture more efficiently than more dense stands. Bunch grasses will remain in rows at the desirable spacing while rhizomatous grasses will spread and form a dense stand.

The stems of grasses are jointed (i.e. they have nodes) and are round or flattened in cross section. This distinguishes them from the sedges (sometimes incorrectly called slough grass) which have triangular stems. Grasses with tall-growing leafy stems are very well suited to machine harvesting, while grasses which have mostly basal leaves and few stems are more suited to pasture use.

Grass leaves have parallel veins and are either flat, folded or rolled. The leaf is the structure where most food manufacturing occurs. Leafy growth is therefore necessary for good health and growth of the plant. This is an important factor related to grazing and cutting management.

The inflorescence (i.e., seed head) is usually a spike (wheat-like) or a panicle (oats-like). Almost all grasses are cross-pollinated by wind. Seeds are borne on the inflorescence.

Grasses offer adaptability and flexibility. Various grass species have superior adaptation to extreme climatic and soil factors. This includes a high tolerance to flooding, water-saturated soil, drought, heat, cold, salinity, acidity, and alkalinity. Many grasses are very long-lived; well established stands of some species are more or less permanent.

For pasture, the use of mixtures containing at least one-half grass, combined with proper pasture rotation, minimizes bloat losses. The growing point of most grasses is at, or even below, the soil surface and is therefore not removed by grazing livestock. A significant percentage of the total leaf surface necessary for food manufacturing is below the grazing level. Although heavy grazing still results in low yields, it does mean that grasses are better adapted than legumes to withstand grazing pressure. Some grasses begin growth in very cool weather and are ready for grazing in the spring long before other forage plants.

Altai Wild-Rye (Figure 46)

Altai wild-rye, *Elymus angustus* Trin., is a native of western Siberia and the Altai mountain region between Siberia and Mongolia. It thrives on semideserts and steppes and grows well on saline soils. It was introduced to Canada from Siberia in 1934 and was first grown in western Canada in 1950.

The wild-ryes should not be confused with the rye grasses, an entirely unrelated species. Wild-ryes have been incorrectly referred to as rye grasses.

Description — Altai wild-rye is a winter hardy, drought-tolerant, long-lived perennial. It has coarse, wide erect basal leaves and seed heads 15-20 cm long on nearly naked, coarse stems 60-120 cm long. The plant is generally a bunch type, but the roots are somewhat creeping. The well developed root system is unique in that

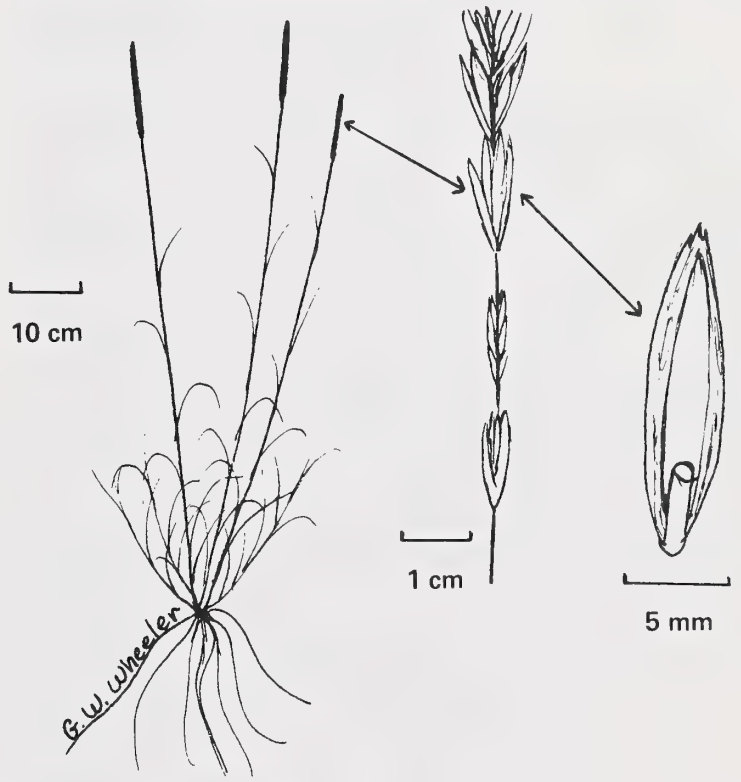

FIGURE 10. Altai wild-rye

it can penetrate 3-4 m deep and can use moisture to that depth more efficiently than other introduced grasses. The seed is about three times as large as that of Russian wild-rye or crested wheat grass.

Adaptation — Altai wild-rye is well adapted to the loams and clay loams of the Brown and Dark Brown soils in the prairie region where it offers great potential as a pasture grass. It grows best in areas that receive about 350 mm of rainfall annually, although its root system is able to make use of water at greater depths than most grasses. The deep root system makes it well adapted to areas with a water table within 3-4 mm of the soil surface. It can withstand saline conditions almost as well as tall wheat grass.

Limitations — Although Altai wild-rye has large seeds that can emerge better from deeper seedings than other grasses, shallow seeding is recommended. The seedlings develop very slowly and require time to become established. Because the seedlings are poor competitors

with weeds, it is important to have a clean seedbed. Weeds should be destroyed by cultivation or through the use of herbicides before seeding. After the grass has developed beyond the three-leaf stage, weeds may have to be controlled again with herbicides. However, once established, Altai wild-rye is very competitive with most weeds. The newly established plants should be allowed to mature and set seed before routine grazing can begin.

Use for Hay — As with Russian wild-rye, most leaves are basal, thus making the forage difficult to harvest as hay. It is not suitable and, therefore, not recommended for hay production.

Use for Pasture — Altai wild-rye is well suited to pasture production. It has a long period of growth that starts in early spring and continues into late fall. It recovers quickly after grazing if moisture is adequate.

Although the growth is coarse, cattle and sheep find it very palatable. It has the ability to retain a high nutritive value throughout summer, fall, and into winter. Cattle have made satisfactory gains during the months of September and October on Altai wild-rye pasture saved for fall grazing. It is especially useful in the winter months since the stiff basal leaves project above shallow snow and remain erect in deep snow forming a bridge across the plants and making them accessible to grazing animals. Cattle maintained their weight during November, December, and January while grazing Altai wild-rye supplemented with oats. It produces well, being similar to Russian wild-rye in yield and protein content. It is somewhat higher than Russian wild-rye in cellulose content and cellulose digestibility, and produces better quality forage than most other species at both the flowering stage and the mature or cured stage of development. To increase pasture production, include alfalfa with Altai wild-rye in alternate rows or in a cross-seeded pattern. In dry areas, the rows should be about 90 cm apart and in the moister locations 45-60 cm apart.

Russian Wild-Rye (Figure 47)

Russian wild-rye, *Elymus junceus* Fisch., was introduced to Canada from Siberia by the University of Saskatchewan in 1926. It was grown at various locations in western Canada and appeared very promising as a forage crop; however, because of its erratic seed yields, it did not come into common use until the 1950s.

Although it had been introduced to North Dakota in 1907, where it was grown in nursery rows, the first recorded introduction was grown at Mandan, North Dakota in 1927 and seed from this source was released to the public in 1941 and 1942.

It is unique among grasses because of its high digestibility and exceptionally long season of use. It is one of the earlier spring grasses and provides excellent dryland pasture.

The wild-ryes have been incorrectly referred to as rye grasses and have been confused with them.

Description — Russian wild-rye is a large bunchgrass that is a long-lived perennial. It has an abundance of long, dense, basal leaves that are 15-45 cm long and up to 6 mm in width. Plants vary from light to dark green, with many shades of blue-green. The erect naked stems, about 90 cm

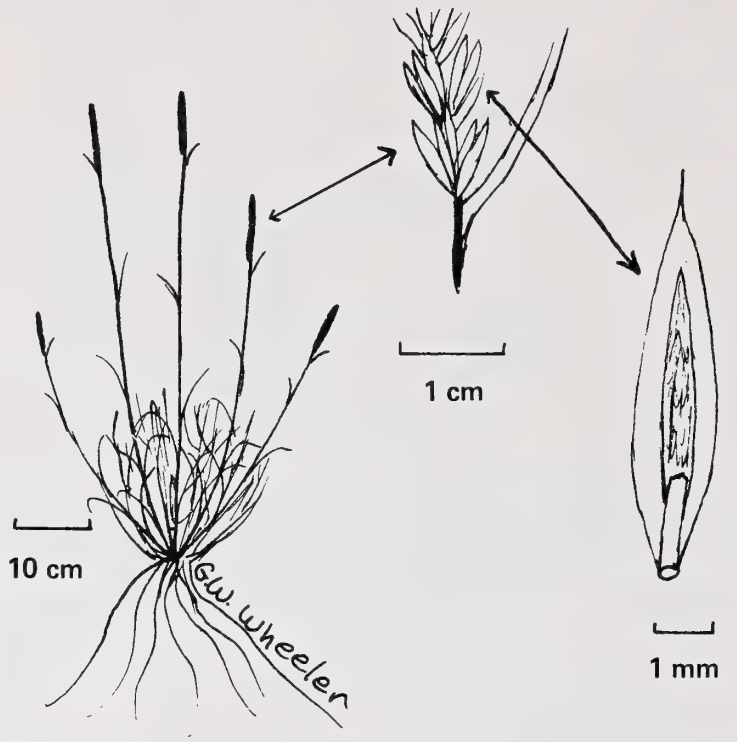

FIGURE 11. Russian wild-rye

tall, have flowering heads that form a dense erect spike. The seed shatters very readily at maturity.

The seed is about the same size as crested wheat grass seed. Germination is high and the seed remains viable up to five to six years.

The roots are fibrous and may penetrate to a depth of 2.5 - 3 m. About 75% of the total roots are in the surface 15 cm but they have a wide horizontal spread and may draw heavily on moisture for a distance of 1.2 - 1.5 m.

Its long season of growth and its vigorous soil-feeding habit make this species an excellent competitor with weeds once the grass is well established.

Adaptation — Russian wild-rye is well adapted to the loam and clay soils of the prairies and the drier parts of the Black soil zone. It can be grown on a fairly wide range of soil types, but is most productive on fertile loams. It does poorly on soils of low fertility. It is more difficult to establish on sandy soils in dry areas than crested wheat grass, but once established it does very well.

It is exceptionally tolerant of cold and drought and is highly tolerant of salinity. It is fairly tolerant of alkalinity.

Generally, Russian wild-rye can be grown successfully wherever crested wheat grass is grown, but it is primarily a pasture grass.

Limitations — Russian wild-rye requires special attention during the year it is seeded since it is very difficult to establish. Seedlings are slow growing and weak so that more time is required for establishing a stand. The plants should be allowed to mature and set seed before they are grazed.

This grass does not tolerate spring flooding and is generally not well adapted to the more cool and moist areas of Alberta.

Use for Hay — Russian wild-rye is not well suited to hay production. Most of the growth is from basal leaves, which are difficult to pick up with harvesting equipment. Hay yields are lower than those of crested wheat grass or smooth brome grass.

Use for Pasture — This grass is well adapted for use as pasture in dry areas and established stands are more or less permanent. It is as long-lived as crested wheat grass.

The forage is very palatable, having a longer growing period than most dryland grasses with an ability to cure on the stem. This allows for a long grazing season. It is also very tolerant of grazing and regrows quickly after clipping. Although grazing can continue from early spring to winter, it is frequently best to graze this grass lightly in the spring, and save most growth for late summer and fall when other grasses are unproductive or low in quality. It remains palatable and of adequate nutritive quality for mature stock on winter maintenance rations.

Yields are similar to those of crested wheat grass. Wide row spacing increases production. Yields are also increased by seeding mixtures with legumes. Seeding the legume in alternate rows or cross-seeded rows decreases competition from Russian wild-rye.

Seed crops must have crop residues removed after harvest to maintain good seed yields. Light grazing should begin as soon after seed harvest as possible.

Crested Wheat Grass (Figure 48)

Crested wheat grass is an important cultivated grass in western Canada. It is native to the cold dry plains of eastern Russia, western Siberia, and central Asia. It was first introduced from western Siberia to the University of Saskatchewan in 1911 and throughout western Canada in 1927. A stand seeded in 1928 at the Agriculture Canada Research Sub-station, Manyberries, is still productive.

There are two types of crested wheat grass. The diploid (2n = 14) or Fairway type, *Agropyron cristatum* (L.) Gaertn., has smaller seeds, grows shorter and has finer leaves and stems than the tetraploid (2n = 28) or standard type, *Agropyron desertorum* (Fisch. ex Link) Schult. The diploid types live longer in the Black soil zone than the tetraploid types, but the tetraploid types remain greener than the diploid types under severe drought.

It has been suggested that at least five or six species make up the crested wheat grass complex. This complex also may involve mechanical mixtures from seed or hybrids between closely related species.

Description — Crested wheat grass is an extremely long-lived, bunch-type grass. It is very winter hardy and has an extensive, deep, fibrous root system that gives it excellent drought resistance. Its leaf growth is rapid and steady from mid April to late June and ends by mid July

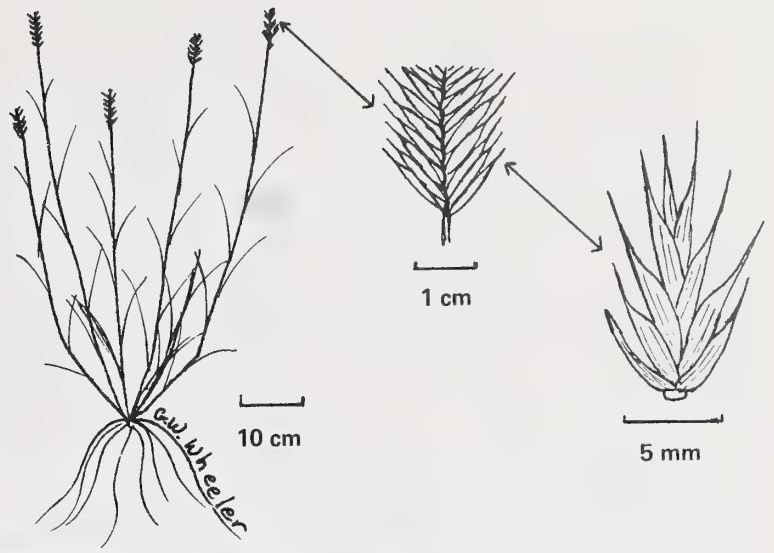

FIGURE 12. Crested wheat grass

when seeds start to ripen. Stems are upright and may reach a height of 90 cm. Seeds shatter soon after maturity and seedlings volunteer readily.

Adaptation — Crested wheat grass is adapted to the drier areas of Alberta, especially the Brown, Dark Brown and Black soil zones. It does well on most good soils, including heavy clay, but it is also noted for its ability to establish itself on sandy soils. The grass is particularly adapted to dry conditions, withstands close grazing and trampling, and competes successfully with plants of other species. It is fairly tolerant of high alkalinity.

Like most other wheat grasses, it is established quickly and easily. Seeds can remain alive in dry soil for long periods until moisture is adequate for germination.

Crested wheat grass stands are responsive to fertilizer. Applications of nitrogen will revitalize unproductive or old stands.

Limitations — This forage is generally not well adapted to Gray Luvisol or the moister parts of Black soil zones where cool, short seasons with ample moisture prevail. This is particularly true of tetraploid types which lack resistance to root rots. Crested wheat grass tolerates only a short period of spring flooding and is intolerant of high water tables. It has only a fair tolerance to alkali salts and acidity.

Use for Hay — Crested wheat grass compares well with other grasses in hay yield and quality, but deteriorates rapidly after heading. It dries rapidly after cutting. Although this forage is vigorous and competitive, the strong bunch habit of growth allows space for legumes to grow. In the drier areas of Alberta, it is often preferred for mixtures with legumes. Regrowth after hay cutting is very poor.

Use for Pasture — This grass is best suited to pasture production as established stands can be considered more or less permanent. It yields well and is very palatable early in spring. It is very tolerant of grazing. However, it becomes dormant and less palatable in the heat of

summer with some growth occurring again in the fall if moisture conditions are good.

Compared to native prairie range, it yields about twice as much and, since it is more tolerant of grazing, it can be stocked three times as heavily early in the season. However, it does not tolerate over-grazing. About 5 cm of growth should be left ungrazed at the end of the season.

Crested wheat grass pastures grow best and are the most nutritious in the early cool part of the growing season.

Intermediate Wheat Grass (Figure 49)

Intermediate wheat grass, *Agropyron intermedium* (Host) Beauv. is a vigorous sod-forming grass native to central Europe, the Balkans, and Asia Minor. It was introduced into the U.S.A. from the Maikop region of Russia in 1932 and into Canada a few years later.

In its native habitat, it grows on high lime soils along hillsides and on plains. It produces good hay and pasture yields.

Description — Intermediate wheat grass is a short-lived, perennial sod-forming grass. It has erect stems with a heavy growth of basal leaves. The plants begin growth in early spring and reach a height of 90-150 cm by mid-summer. The heads are from 15-25 cm long and are typical of the wheat grasses.

The seed is much larger than that of smooth brome grass, resembling a small oat, and it is easily seeded through a grain drill.

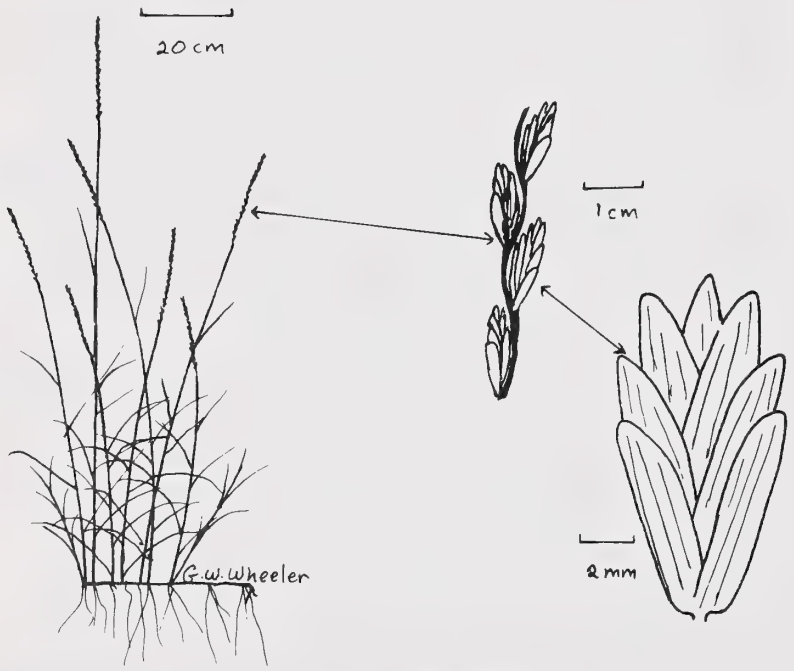

FIGURE 13. Intermediate wheat grass

Intermediate wheat grass has a deep-feeding root system as well as creeping root stalks. Under irrigation, it is a very aggressive sod-former. Under dryland conditions, it appears more or less like a bunchgrass.

Adaptation — Intermediate wheat grass grows best on well-drained, fertile soils with ample moisture, and tolerates alkalinity well. It is suited to those areas where moisture conditions are favorable, for example, in the Black soil zone and the moister portions of the Dark Brown soil zone. In general, it does well where brome grass does well. It grows well in irrigated areas, particularly if grown with a legume.

In the drier areas, intermediate wheat grass yields more than smooth brome grass and crested wheat grass for the first three crop years, but then productivity declines. It can be used for hay or pasture and grows well in areas where annual rainfall is at least 375 mm.

Limitations — The drought resistance and winter hardiness of intermediate wheat grass is lower than that of crested wheat grass. It is short-lived and good pasture stands are difficult to maintain for much more than six years.

Intermediate wheat grass can suffer from winter killing after dry conditions in the fall. It is less competitive with weeds than crested wheat grass. It does not tolerate salinity and wet conditions, and does not persist in areas with poor drainage.

Use for Hay — Intermediate wheat grass by itself, or in mixture with legumes, produces good yields of high-quality palatable hay. On irrigated land, an intermediate wheat grass-alfalfa mixture outyielded 10 other grass-alfalfa mixtures over a period of four years. On dryland, mixtures of intermediate wheat grass and alfalfa outproduce crested wheat grass-alfalfa mixtures and smooth brome grass-alfalfa mixtures.

It appears to be especially suited to seeding in mixtures with alfalfa because it is not quite ready to flower when the alfalfa is ready to cut. For this reason, the hay cut from the mixture is of excellent quality.

Use for Pasture — Intermediate wheat grass is a useful pasture crop. In many areas, it consistently outyields smooth brome grass and crested wheat grass. It is rated as one of the best grasses as it produces more pasturage and adds more fibre to the soil than most other grasses.

In pasture tests, intermediate wheat grass-legume mixtures consistently outyield other grass-legume mixtures under irrigation. Because of the higher forage yield, intermediate wheat grass pastures can be stocked heavier than pastures of other grasses.

It provides excellent pasture from early spring to late summer and is very palatable to all classes of livestock. The foliage does not freeze back with an early frost as smooth brome grass does and can be used for fall pasture when moisture is favorable. Most growth is produced in spring and early summer, but regrowth is better than that of smooth brome grass.

Pubescent Wheat Grass (Figure 50)

Pubescent wheat grass, *Agropyron trichophorum* (Link) Richt., is closely related to intermediate wheat grass and originated in the same region. It was introduced into the U.S.A. in 1934 and into Canada a few years later.

Pubescent wheat grass is similar to intermediate wheat grass in most respects but is distinguishable by the pubescence, or presence of short stiff hairs, on the heads and seeds. Plant types generally gradate from one species

to another and it has been suggested that only one species *(A. intermedium)* be recognized.

It is longer lived, more drought tolerant, and more winter hardy than intermediate wheat grass. It is useful for hay, pasture, and waterways on farmland. Its outstanding feature is its ability to stay green into the summer months when soil moisture is adequate.

Description — Pubescent wheat grass is a long-lived, sod-forming grass. It has slightly more drought tolerance and ability to spread by rhizomes than intermediate wheat grass. The plants grow erect with a heavy growth of basal leaves. Stems grow to a height of 90-150 cm and produce

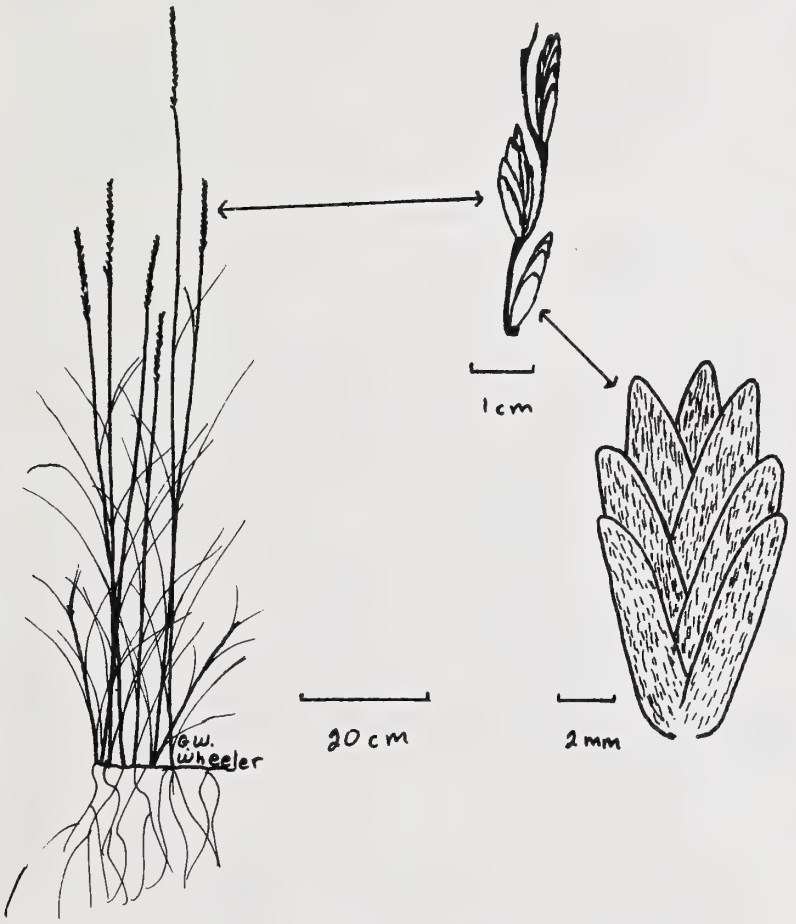

FIGURE 14. Pubescent wheat grass

seed heads that are 10-20 cm long. The plants, seed heads, and seeds are somewhat hairy.

Seeds of pubescent wheat grass and intermediate wheat grass are frequently found as a mixture. The two species readily cross-pollinate and plant types gradate from one species to another.

Adaptation — Pubescent wheat grass is adapted to a wide range of conditions with respect to precipitation, temperature and elevation, and is better adapted than intermediate wheat grass to low fertility soils, alkaline soils, and low rainfall areas. It has some tolerance to saline soils.

It grows well in areas that have at least 300 mm of annual precipitation. It also grows well under irrigation, where repeated annual applications of nitrogen maintain productivity for longer periods.

Pubescent wheat grass is adapted to the Brown and Dark Brown soil zones. It makes excellent growth the first two to three years in the Black soil zone, but then the production declines very rapidly so that it is less suited to this area than intermediate wheat grass.

Limitations — Its strongly creeping rooted characteristics result in an unproductive stand in a few years, especially under good moisture conditions. However, yields of forage depend upon total annual precipitation and the distribution of rainfall in summer.

It is not as drought resistant as crested wheat grass and during drought conditions, stands may kill out. It has a low tolerance of wet conditions and does not persist in areas with poor drainage.

Use for Hay — Pubescent wheat grass produces good yields of high quality hay. It is higher than crested wheat grass in total digestible nutrients, lower in lignin content, and about equal in protein content until it has flowered. It stays green longer and matures later than crested wheat grass.

For maximum production, pubescent wheat grass, like intermediate wheat grass, should be seeded in a mixture with alfaifa to obtain higher quality hay and higher yield.

Use for Pasture — It provides a nutritional pasture and is very palatable to all classes of livestock. It can be grazed as early as crested wheat grass in the spring and also during the summer.

Yearling steers grazing irrigated pubescent wheat grass make excellent gains. These gains are greater than those on orchard grass, reed canary grass, or creeping red fescue. Because of its early spring growth, pubescent wheat grass can be grazed one to two weeks earlier than these other grasses. It generally does not provide grazing during late June - early July. It provides 25% less grazing time than the other grasses when stocked at the same intensity.

Slender Wheat Grass (Figure 51)

Slender wheat grass, *Agropyron trachycaulum* (Link) Malte, is a short-lived, native perennial bunchgrass that is widely distributed. It was the first native grass to be generally used for seeding in western Canada and was referred to as western rye grass. However, very few seedings have been made of this grass, probably because it is short-lived.

Excellent first-year vigor is the outstanding attribute of this grass. The seed has a high germination rate and excellent emergence characteristics. It can provide a good grass cover on areas that have been disturbed and may be used for seeding low-lying areas that tend to be alkaline.

Description — Slender wheat grass has a leafy bunch growth habit with dense, fibrous roots extending to a depth of 45 cm. The bunches enlarge by tillering. The seed stalks are 60-120 cm tall with an abundance of leaves. A relatively consistent character is the reddish or purple color of the stems near the base. The seed head has a characteristic slender appearance that distinguishes this grass from other wheat grasses. The seed is larger than that of crested wheat grass and is easily seeded with conventional seed drills.

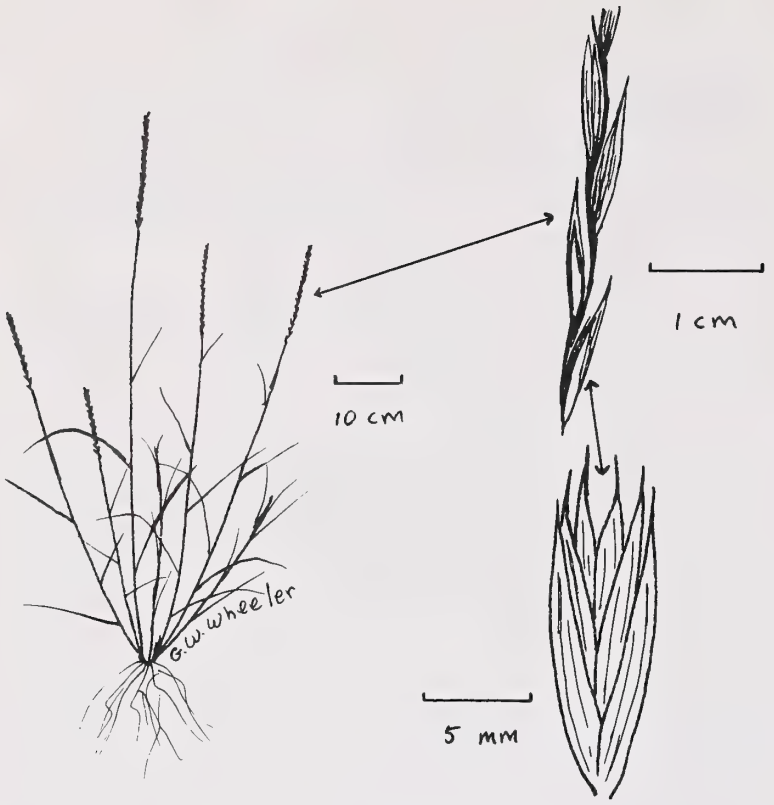

FIGURE 15. Slender wheat grass

Adaptation — It is adapted to a wide range of soils, but prefers the sandy loams. It persists better than smooth brome grass or crested wheat grass on heavy textured soils, and has been used in mixtures on irrigated land. Slender wheat grass is surpassed only by tall wheat grass in tolerating alkali soils. It is less drought resistant than crested or western wheat grass.

Limitations — Slender wheat grass is relatively short lived. It yields well for the first three to four years, and then stand density decreases rapidly. It is not as competitive with weeds as other wheat grasses, but it is shade tolerant.

It frequently matures late enough to be severely affected by drought. It should not be grown in areas that receive less than 350 mm of precipitation annually. It is limited to soils with good moisture conditions, but does not tolerate waterlogged conditions. It is best adapted to the northern and eastern portions of the prairies rather than to the dry central parts.

Use for Hay — Good yields of high quality hay are obtained from slender wheat grass stands. When used for hay, it should be sown in mixtures with more permanent grasses which will take over the stand as the slender wheat grass dies out. It increases the stand yield during the first two to three years after seeding. Its protein content is lower than that of crested wheat grass and smooth brome grass during the early part of the season and at maturity, but it is about equal at midseason.

Use for Pasture — Slender wheat grass begins its growth relatively early in the spring and produces an abundance of palatable forage liked by all classes of livestock. The forage cures well and furnishes considerable quantities of nutritious feed for winter grazing. It is not resistant to close grazing and heavy grazing reduces stands quickly.

It is useful in sweet-clover - grass mixtures for pasture in rotation with annual crops, as both species are short lived.

Western Wheat Grass (Figure 52)

Western wheat grass, *Agropyron smithii* Rydb., also known as bluejoint, is a native grass in Alberta. It grows in fairly dense stands on clay soils in association with green needlegrass, on saline soils with alkali-tolerant grasses, and in sparse stands on upland sites with blue grama or the speargrasses. It frequently occurs as the dominant grass throughout the area. It also occurs on abandoned cultivated fields where the original stand of western wheat grass was not entirely eliminated by cultivation.

It has several characteristics that make it exceedingly valuable for use in revegetation and erosion control. Its hardiness and drought resistance and its capacity to spread by underground rhizomes have outstanding value for conservation. It can survive drought and also flooding in shallow lake beds subject to overflow or excess surface drainage from spring run-off.

Description — Western wheat grass is a long-lived, sod-forming perennial. It has a well-developed root system with a mass of surface roots feeding to a depth of 20 cm and deep feeding roots that penetrate to a depth of 150 cm.

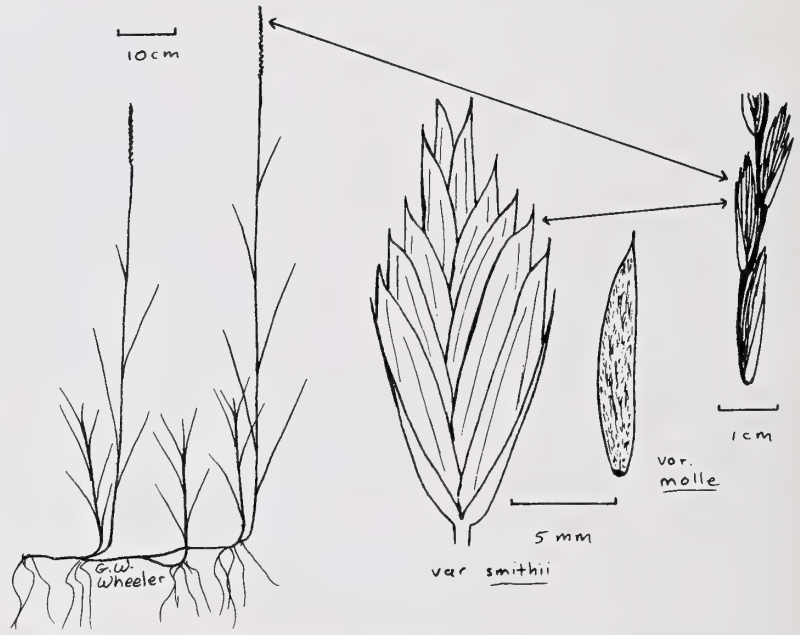

FIGURE 16. Western wheat grass

Thus the plant is well adapted to survive drought and to take advantage of light rains that soak only the top surface of the soil.

Plant growth is vigorous, with seed heads at a height of 60-90 cm and leaves 20-30 cm long. The leaf blades do not droop but are more or less stiff and erect. The leaves are blue-green, and the entire plant is covered with a greyish bloom, which gives it a distinctive coloration. The seed heads are 5-15 cm long, and the seed is about twice as large as that of crested wheat grass.

Adaptation — Western wheat grass is adapted to a wide range of soils, but prefers the heavy and somewhat alkaline soils characteristic of shallow lake beds or along intermittent water courses that receive excess surface drainage water from spring run-off.

It is common in the Brown and Dark Brown soil zones where it grows in almost pure stands or in mixtures with other grasses. It is best adapted to well-drained bottom lands, especially if additional moisture is available, and can grow on heavy clay soils. This grass can grow through thick layers of silt along streams and can withstand considerable flooding. Western wheat grass is winter hardy and drought resistant.

Limitations — Plants develop slowly from seed and, because the young seedlings are small and inconspicuous, the new stand often appears a failure. However, the plants spread rapidly through creeping roots and provide the cover desired by the second year.

Use for Hay — Western wheat grass produces leafy and highly nutritious hay that has been the standard of quality for range hay. The yield of hay depends greatly upon moisture during the early part of the growing season. It produces excellent yields on spring-flooded sites.

It has a protein content of about 18% in early May, but this declines to about 4% by October. The digestible carbohydrates increase from about 40% to 50% during the same period. Feeding studies have shown that well-cured hay cut late in the leaf stage will be 60% digestible.

Use for Pasture — It is palatable to all classes of livestock during the growing season. Growth begins early in the spring and continues until fall. When mature, its leaves and stems become harsh and woody, but it cures well on the stem and provides good winter grazing.

Care should be taken to ensure that it is not grazed too closely. Heavy grazing during the growing season will reduce the forage yield, and may result in the death of many of the plants. Under continuous heavy grazing, it will disappear from stands.

Northern Wheat Grass (Figure 53)

Northern wheat grass, *Agropyron dasystachyum* (Hook.) Scribn., known as thickspike wheat grass, is native to the prairie region. It grows in mixed and sparse stands with western wheat grass or the speargrasses on clay and loam soils, and occasionally in nearly pure stands on sandy soils. It is the most widely distributed of all native grasses and is considered a valuable forage plant in the prairie region.

It is closely related to western wheat grass but is more drought tolerant. Both species are very hardy.

It can be used for hay although it is more productive when utilized for pasture. It can also be used for pasture and hay production in the revegetation of depleted rangeland, mechanically disturbed areas, roadsides, construction and oil and gas well sites, and other areas that will receive little or no maintenance.

Description — It is a long-lived perennial that is very drought tolerant. It has a three-way root system, creeping underground rootstocks spread and reproduce the plant, a very dense shallow root system penetrates to a depth of about 25 cm, and a few deep roots penetrate to a depth of at least 60 cm. This combination of root types increases

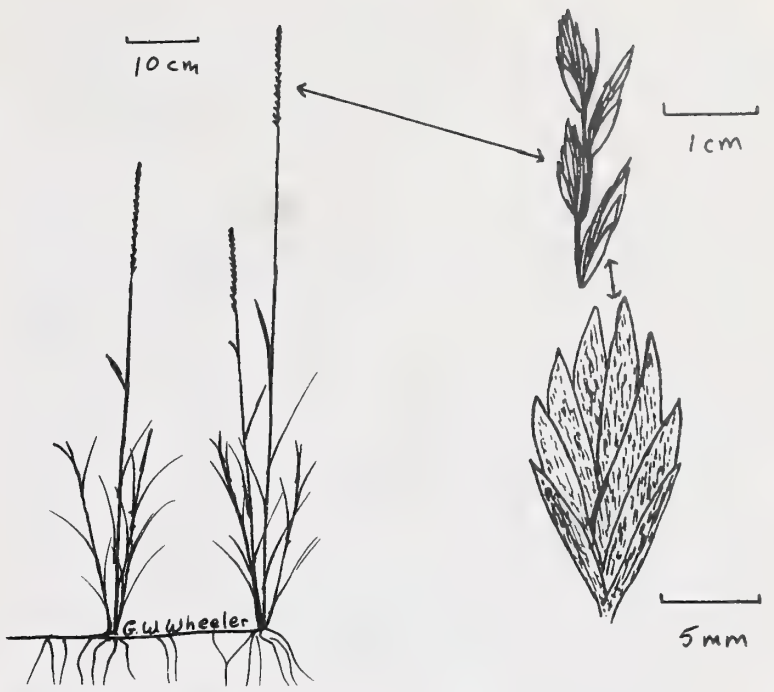

FIGURE 17. Northern wheat grass

the tolerance to drought and its resistance to invading weeds.

The plants are tufted with erect leaves and stems that are 45-75 cm tall. The leaves are light greyish green and are rolled when dry conditions prevail. The seed heads are 6-12 cm long, while the seed is about 50% larger than that of crested wheat grass.

Adaptation — Northern wheat grass is adapted to a wide range of soils, but prefers the medium to coarse textured soils. It has a wider range than other wheat grass and is found growing in sand dunes to heavy alkaline areas.

It is common in the moister parts of the Brown soil zone and in the Dark Brown soil zone, and occurs in the drier parts of the Black soil zone. It prefers dry areas, but responds to additional moisture and can withstand considerable periodic flooding.

It can be grown on soils that are subject to water or wind erosion as it produces a good ground cover. It is easy to establish as the seedlings exhibit good vigor. It is adapted to moderately alkaline soils.

Limitations — Once established, the stands thicken and tend to become unproductive. Dense stands seldom set seed, but individual plants will do so during years when growth continues for the 115 days required from date of first growth to seed maturity.

Northern wheat grass seedlings are small and inconspicuous when young, but are drought resistant. They compete fairly well with weeds and other grasses, although not so well as crested wheat grass.

Use for Hay — Northern wheat grass produces palatable and nutritious hay, although it is more productive when utilized as pasture. The grass cures on the stem and retains much of its nutritional value.

It has a protein content of about 20% in early May which decreases to about 4% in October, while the digestible carbohydrates remain at about 45% from emergence until maturity.

Use for Pasture — It is palatable to all grazing animals. It starts growth early in the spring and provides good grazing until early fall when it becomes wiry. It can be grazed in the spring or early summer to complement native rangeland after crested wheat grass has headed and matured.

The long creeping roots enable the plants to withstand heavy grazing and considerable trampling. Once established, the northern wheat grass plants, if conservatively grazed, normally continue to spread and thicken the stand.

Streambank Wheat Grass

Streambank wheat grass, *Agropyron riparium* Scribn. & Smith, is a native, cool-season, sod-forming grass. It is especially suitable for use in soil- and water-conservation work. Its dense low-growing sod is highly resistant to erosion. The top growth is relatively short and fine-leaved, and requires a minimum of maintenance.

Although this grass has a low production record, it can be utilized as hay or pasture under favorable moisture conditions.

It resembles northern wheat grass and differs from it mainly by the lack of hairs on the heads and seeds. It also has numerous slender rhizomes that are more vigorous than those of northern wheat grass. It has been considered as the same species or as a variety of northern wheat grass, but is now generally recognized as a species in its own right.

Description — Streambank wheat grass is a long-lived perennial that is very drought tolerant. It has deep roots and very strong and vigorous rhizomes that enable the grass to spread rapidly to form a good ground cover. The plants are short with narrow, tough, smooth leaves.

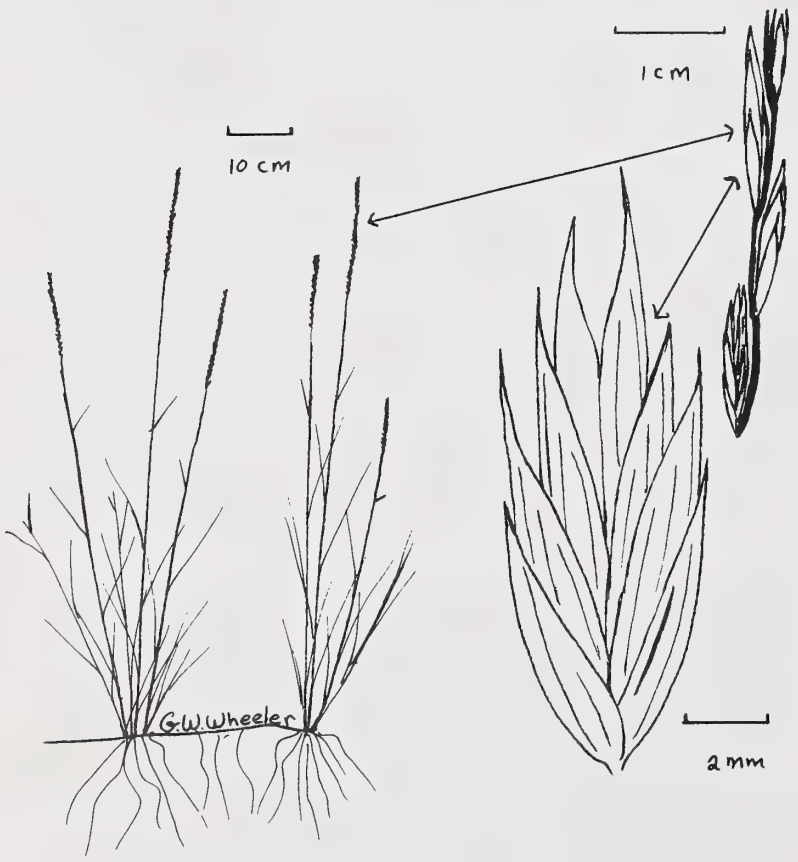

FIGURE 18. Streambank wheat grass

Streambank wheat grass has leaves 10-25 cm high and stems up to 90 cm high. The seed head is 5-10 cm long. The seed is somewhat larger than that of crested wheatgrass.

The leaves are light greyish green and are somewhat curled at the margins.

Adaptation — Streambank wheat grass has special uses in soil and water conservation work and offers excellent protection against soil erosion on roadsides, airports, and irrigation ditches. Under dryland conditions it can be used as permanent lawns for homes, playgrounds, parking areas, and machinery yards. Its thick sod keeps it weed free and provides a very smooth cover that is permanent and requires a minimum of maintenance.

It is adapted to a range of soils in the Brown and Dark Brown soil zones and tolerates moderately alkaline soils.

It is very drought tolerant and the seed germinates quickly, even when rainfall is scanty. It tolerates periodic flooding, but requires well-drained soils.

Limitations — Streambank wheat grass produces a low forage yield and, since it is not especially palatable, it has limited value for farm use. The dense sod produces little seed under dryland conditions. It is not competitive with other grasses on wet sites.

Use for Hay — It is the lowest yielding grass of all the cultivated wheat grasses on dryland or irrigated land. The low yields are attributed to the predominantly leafy growth.

Use for Pasture — Streambank wheat grass can be used for pasture, even though the plants are short and not especially palatable. The leafy growth has a well-balanced nutrient composition.

Tall Wheat Grass (Figure 54)

Tall wheat grass, *Agropyron elongatum* (Host) Beauv., is a tall, coarse late-maturing bunchgrass. It is native to saline meadows and seashores of southeastern Europe and Asia Minor. It was introduced from southern Russia into Canada in 1929 by the University of Saskatchewan.

For many years, it created little interest because it is coarse, not particularly drought tolerant, and slow to establish. However, it has demonstrated its ability to thrive in subirrigated, saline soil where foxtail barley is usually the dominant grass.

Description — Tall wheat grass is a bunchgrass that extends its size by producing tufts on short rootstocks at the edge of mature plants. Long, coarse, light green basal leaves surround several leafy stems that are 90-180 cm tall. The heads are similar to those of intermediate wheat grass but are generally longer, 15-25 cm long. The seed is somewhat larger than that of intermediate wheat grass and generally does not germinate as well.

Tall wheat grass is late maturing, flowers during the last two weeks in July, and ripens seed in September.

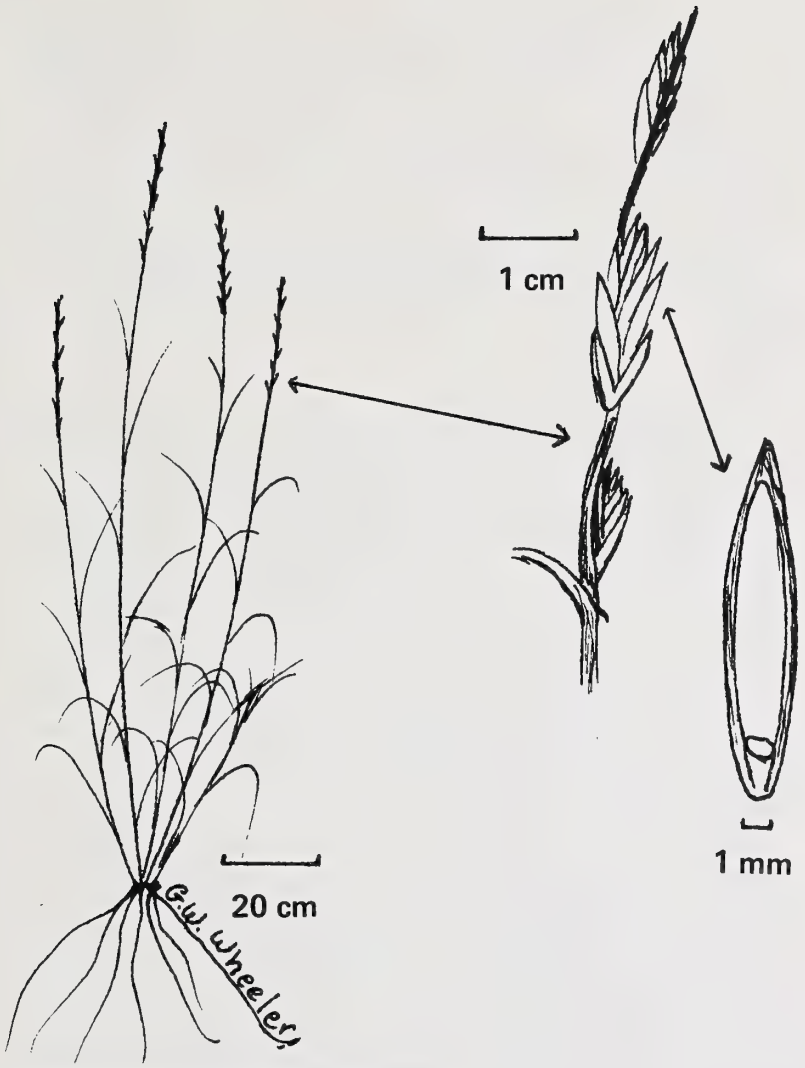

FIGURE 19. Tall wheat grass

Adaptation — Tall wheat grass is especially tolerant of saline soils. It is adapted to irrigated or subirrigated saline soils and to imperfectly drained alkali soils. It prefers soils with a high water table. It can survive five weeks of flooding in the spring and can therefore be seeded on land that is wet for some time in the spring.

The ability of this grass to grow and maintain itself on moist moderately alkaline soils has resulted in its extensive use in reclaiming such areas. It will not develop in dry alkaline sites, nor will it grow where the soil is so alkaline that native plants or weeds cannot persist.

It will grow and persist in areas receiving more than 375 mm of precipitation annually. It is winter hardy.

It can be established with good cultural methods in most areas except where high amounts of salt are present. In such situations, the soluble salts should be leached out or flushed off and the existing competition should be eliminated by plowing when the soil is dry. It is usually seeded alone.

Limitations — The seed generally does not germinate well and the seedlings develop slowly. The young seedlings do not compete successfully with weeds during the establishment year.

Under dry conditions, tall wheat grass does not live long; but where moisture conditions are good, it produces well for many years. It is not particularly drought tolerant.

Protection for one full season is required for establishing tall wheat grass on irrigated land and for two seasons under dryland. The newly established plants should be allowed to mature and set seed before harvesting or grazing.

Use for Hay — Tall wheat grass makes fair quality hay and can be used successfully for silage. In the early heading stage, it is higher in digestible protein and in total digestible nutrients than other wheat grasses.

It produces high yields of hay which are readily eaten by sheep and cattle, if cut before or shortly after heading.

Use for Pasture — Tall wheat grass, because of its late maturity, provides a long grazing period when used for pasture, but it is not as palatable as most other wheat grasses or other pasture grasses. When planted in pure stands and fenced, tall wheat grass is readily grazed by sheep or cattle, especially the coarse leaves. It must be heavily grazed to maintain the plants in the vegetative state, although a stubble of at least 15 cm should be left to prevent close grazing during the following season.

Perennial Rye Grass (Figure 55)

Perennial rye grass, *Lolium perenne* L., originated in southern Europe, North Africa, and southwest Asia. It is believed to have been first cultivated for forage in England in 1677 and introduced to the U.S.A. in the early 1800s. It is one of the most important pasture grasses throughout western Europe, Britain, New Zealand, and the southern Atlantic and northwestern States. It has become an important pasture species in eastern Canada and southern British Columbia.

It exhibits a true perennial growth habit and is similar in appearance to annual rye grass. Like annual rye grass, it is a diploid with 14 chromosomes; they cross readily with each other. Natural hybridization between those two species has resulted in intermediate types that are called common rye grass. Controlled crosses between these two species have resulted in hybrid or tetraploid ($2n = 28$) types that are higher yielding, recover well after cutting, are palatable, have vigorous seedlings, and possess some resistance to rust.

Description — Perennial rye grass is a relatively short-lived perennial. It is a bunchgrass with a shallow, fibrous root system. Leaves are dense, dark green, glossy, and folded when young. The short stems, 30-60 cm tall, are nearly leafless and terminate in a slender, stiff spike. The spikelets set at right angles to the stem distinguish it from other common grasses.

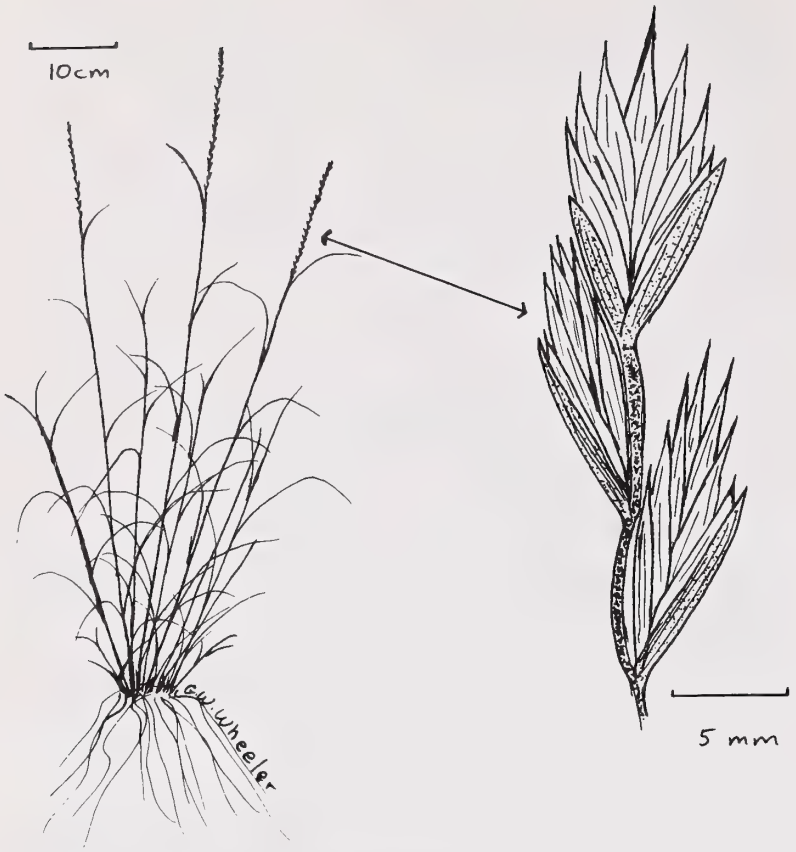

FIGURE 20. Perennial rye grass

Adaptation — Its area of adaptation is limited to the moister parts of the Gray Luvisol and Black soil zones and the irrigated areas. It is relatively hardy, although winter kill is a problem in central and northern parts of Alberta. To produce high yields, it requires 750-1250 mm of rainfall annually and high fertility. It is adapted to a wide range of soils, including heavy clay and imperfectly drained soils, but prefers medium to high fertility. In some areas, it is considered as a wetland grass, although production usually declines as the drainage gets poorer.

Limitations — Perennial rye grass does not persist as long as some other pasture grasses but is quite satisfactory for three to four years in southern Alberta.

It is not a dryland grass and generally is not adapted to areas with extremes of cold, heat or drought.

It does not yield well when temperatures rise and soils dry in July and August, and if drought continues into September, its recovery is slow. While it has a very high requirement for moisture, it will not tolerate ponding.

Use for Hay — Perennial rye grass is better adapted for pasture use than for hay production as its growth is generally short. However, it can be harvested for hay. Generally, one hay crop can be harvested soon after the pollen is shed, and the regrowth after harvest can provide late summer and early fall grazing or another crop for hay.

The hay should be harvested leaving at least an 8-cm stubble.

Use for Pasture — The principal use for perennial rye grass is for pasture seeding. The combination of good seedling vigor, rapid development, high yields, and good quality forage make it a valuable pasture grass. Newly seeded pasture can be grazed within two months after seeding.

Perennial rye grass grows and develops rapidly so that rather heavy stocking rates are needed to control growth. The use of rotational grazing helps to keep it in a succulent stage of growth. However, early in the season it may be necessary to harvest portions as hay or silage to prevent the forage from becoming coarse and unpalatable.

To produce maximum yields, irrigated perennial rye grass pastures require frequent applications of nitrogen fertilizer.

Italian Rye Grass

Italian rye grass, *Lolium multiflorum* Lam., also called annual rye grass, was grown in the meadows of northern Italy in the thirteenth century. It was reported in France in 1818 and in Switzerland in 1820. It was probably first introduced to this country around 1800, but this is uncertain.

It has many uses. It can be used as a companion crop for spring-sown permanent pastures, since it gives a quick cover for early grazing. It also makes a fine temporary lawn and is used in lawn grass seed mixtures because it produces a turf quickly.

Description — Italian rye grass is commonly considered an annual. Under some conditions it assumes a biennial habit or even behaves as a short-lived perennial. It produces an abundance of dark green leaves and stems that grow 60-120 cm high. The seed heads, or spikes, are 15-30 cm long, slender, and usually weak, with several seeds borne in groups on opposite sides of the stem. The seeds have awns of various lengths.

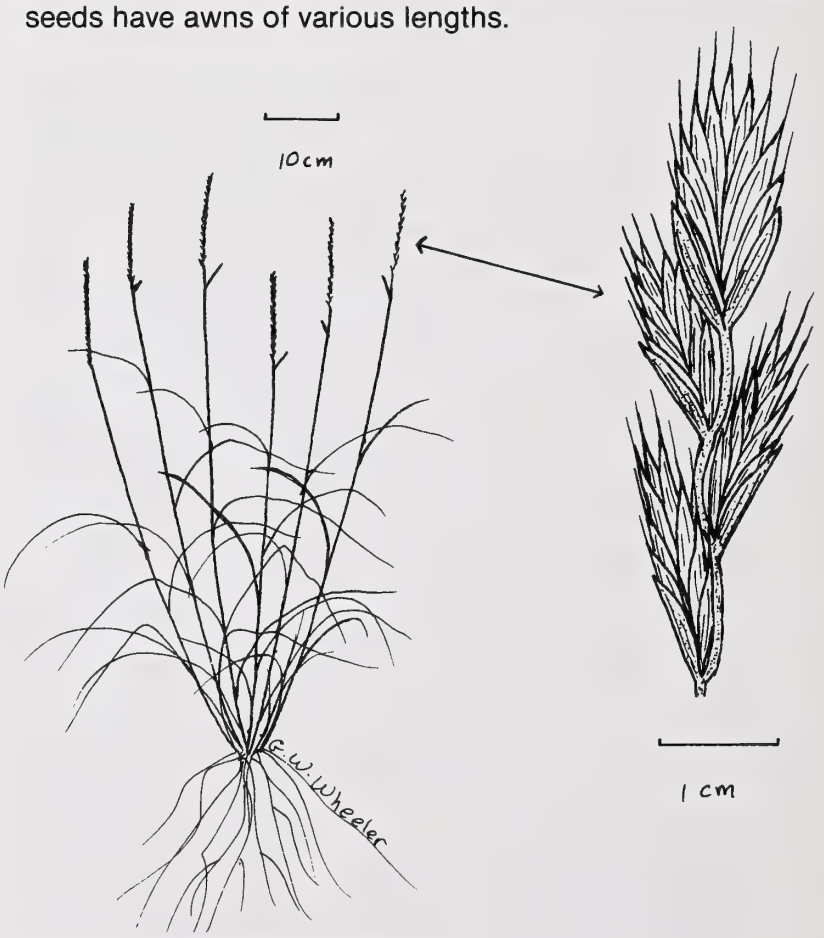

FIGURE 21. Italian rye grass

The outstanding botanical characteristic of the rye grasses is that the spikelets are set at right angles to the stem. This feature distinguishes rye grass from other grasses. It is, however, very similar to perennial rye grass, a related species, and adapted to similar environment and

use. Italian rye grass can be distinguished from perennial rye grass by the awn and stem characters and by the arrangement of the leaf in the young shoot. Awns are present on seed of Italian rye grass and are usually absent on perennial rye grass. The stem of Italian rye grass is cylindrical but that of perennial rye grass is slightly flattened. The leaves of Italian rye grass are rolled in the young shoots but are folded in perennial rye grass. The plants of Italian rye grass are yellowish green at the base while those of perennial rye grass are commonly reddish.

Adaptation — Like perennial rye grass, Italian rye grass is limited to the moister parts of the Gray Luvisol and Black soil zones and the irrigated areas. It is adapted to a wide range of soil types, but produces best on soils of medium to high fertility. It grows best on irrigated land or in areas where annual precipitation is at least 450 mm, and can survive short periods of flooding when the stand is well established.

Limitations — Italian rye grass does not withstand drought or hot, dry weather. It will not survive if winters are too severe, and should be treated as an annual in Alberta. It appears to have no special resistance or susceptibility to disease.

Use for Hay — For hay production, it should be cut when the seed is in the soft dough stage. Italian rye grass is a heavy seed yielder, and if not clipped it will produce seed for a volunteer crop. The hay cures rapidly and when handled properly is bright green. Because of its leafiness and medium-fine stem, the hay is of high quality.

Use for Pasture — Italian rye grass produces excellent pasture, and this is its primary use. It is a very palatable grass. It yields well, for example, with spring seeding under irrigation, and with good soil fertility, grazing can be provided for five animal units per hectare from mid-June until late September. It is possible to graze rye grass early in the season, harvest it for hay when headed, and then use the regrowth for hay or pasture. It will continue to grow well into the fall as long as moisture is available.

Italian rye grass can be grown with spring-seeded fall rye to provide good late summer - early fall pasture or with oats to provide an early season pasture. It furnishes a nutritious pasture after the oats are grazed off. Italian rye grass generally produces forage that is higher in digestibility and protein content than oats.

Smooth Brome Grass (Figures 56 and 58)

Smooth brome grass, *Bromus inermis* Leyss., is the most widely used of the cultivated grasses in Alberta. It was first introduced to California from Hungary in 1880 and to Canada from northern Germany in 1888. Additional introductions from the northern latitudes in Europe led to successful seed production operations in Canada.

Two general types of brome grass exist, the northern and the southern types. The northern type resulted from introductions and importations from northern Europe and were adapted to Canada and the Dakotas. The southern types originated from central Europe and were adapted to Nebraska and Kansas.

Northern brome grass types produce excellent seed crops, are slow to establish, and produce an open sod. Southern brome grass types produce good forage yields, begin growth earlier in the spring, and remain greener in the fall than northern brome grass types. Southern brome grass types are taller, more strongly creeping, and less leafy than northern types, and are reasonably winter hardy. Intermediate types of brome grass have been developed that incorporate desirable characteristics of the southern and the northern types.

Description — Smooth brome grass is a long-lived sod-forming perennial. It develops a deep root system which accounts in part for its tolerance to drought and heat. Stems are generally 60-120 cm long but only half the tillers produce stems.

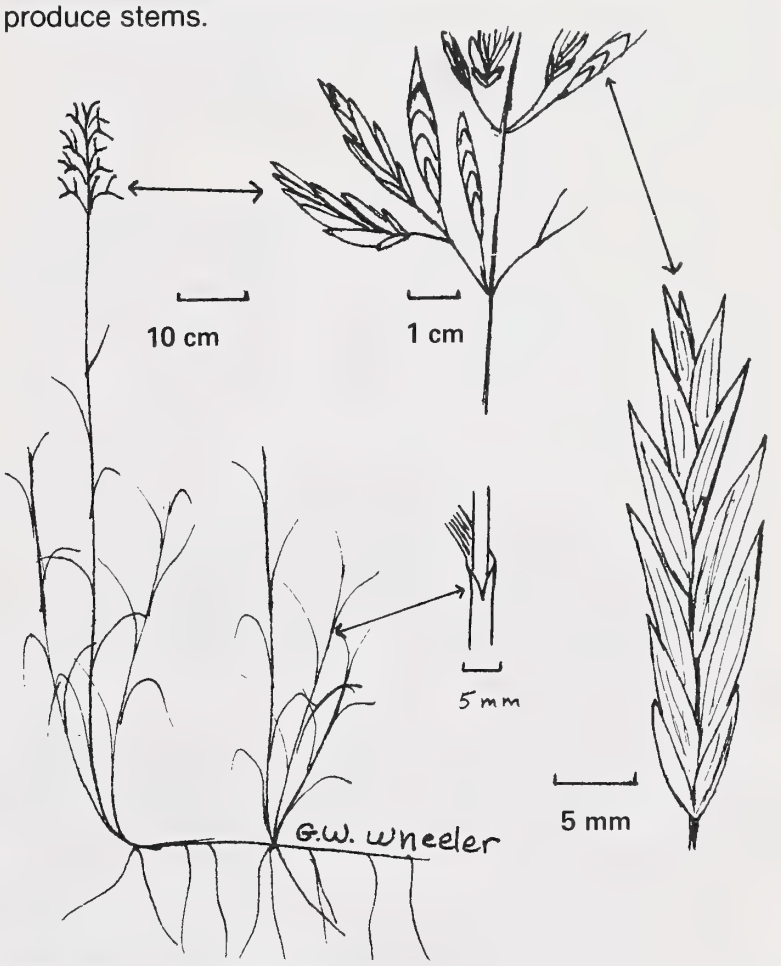

FIGURE 22. Smooth brome grass

It is a cool-season grass that produces leafy vegetative growth early in the season and stems with large panicles in early summer.

Adaptation — Smooth brome grass thrives especially well on moist, well drained areas in the Black and Gray Luvisol soil zones but is adapted to a wide range of soil and moisture conditions. It also grows well in the Dark Brown soil zone and in the more moist areas in the Brown soil zone. It is adapted to both dryland and irrigation.

While it does not withstand extreme drought conditions, it survives some drought and extremes of temperature. It is winter hardy. In dry summer periods, it becomes dormant until the return of cool short days and fall moisture. It is fairly tolerant of alkalinity and is somewhat tolerant of salinity and acidity.

Limitations — Smooth brome grass is the most widely used grass in the province, but it has several shortcomings. Long narrow seeds, which bridge in conventional

seed drills, make it difficult to plant. Once established, full yields are frequently not reached until the second or third year of production. As the stand matures, the continued growth of rhizomes increases tillering until the stand becomes very dense and unproductive. The vigorous rhizomes also make it difficult to eradicate a stand by cultivation. This forage requires fairly good internal soil drainage, although it will tolerate about two weeks of flooding in spring before growth begins, but none during the growing season. It does not normally perform well in areas of excessive rainfall unless it is well fertilized. Diseases are not a major problem, although it is susceptible to winter crown and root rot.

Use for Hay — This high yielding grass is best suited to hay production. Growth is upright, making harvest easy. Although it is very aggressive in a mixture, its tendency to establish itself slowly makes it well suited for use in mixtures with alfalfa. Properly nodulated alfalfa provides it with much needed nitrogen.

Brome grass is high in protein compared to other grasses at similar stages of maturity, especially timothy. However, it is low in energy while timothy is high. These differences in quality are normally less important than total production, however, and the choice between timothy and brome grass can normally be made on the basis of dry matter yield.

Heavy applications of fertilizer can maintain good yields of brome grass for up to 10 years. It is frequently economical to apply nitrogen since this grass is most responsive to fertilizer. The application of fertilizer generally reduces sod-bound conditions since a good supply of nutrients permits a high number of shoots to grow.

Regrowth after hay cutting is generally low in yield. Very early haying and the use of adequate amounts of fertilizer do extend the season of growth and increase second growth yields.

Use for Pasture — Smooth brome grass is commonly used for pasture in Alberta. Spring growth is early. Young plants are very leafy and palatable. Vigorous rhizomes make this grass fairly resistant to elimination by over-grazing. However, smooth brome grass has many weaknesses when used as pasture. Plant growth occurs mainly in the spring and early summer so there is a flush of growth followed by a long period of slow growth. To compound this problem, smooth brome grass is tall growing and almost all leaves required for future growth are within the bite level of grazing livestock. It must be grazed lightly early in the season to let growth accumulate for use later in the season. Also, in late summer and fall when the herd sizes are largest, much more pasture area is required and careful rotation of pastures is necessary to maintain adequate growth.

Meadow Brome Grass (Figures 57 and 58)

Meadow brome grass, *Bromus biebersteinii* Roem and Schult., was collected in Turkey and first introduced to the U.S.A. in 1949. Selections from this introduction resulted in the release of a variety.

Meadow brome grass contains some of the good features of both smooth brome grass and orchard grass. It should be considered a part of the forage family of improved grass species and used as a supplement to, rather than a total replacement for, the other grass species. The grass can extend the prime grazing season as well as increase total forage production, and is very compatible with alfalfa. It yields as much total forage as smooth brome grass, but has much faster recovery and better fall growth. It differs from smooth brome grass in being much less strongly creeping, and is slower to become established. It has more basal leaves. The forage quality is similar to that of smooth brome grass. The vegetative growth is very palatable to all classes of livestock as both green forage and cured hay.

Description — It is a long-lived perennial bunchgrass with a tendency for some vegetative spreading under dryland conditions and a moderate amount under irrigation. This characteristic provides soil protection not found in other bunchgrasses. The stand does not decline in productivity as rapidly as other vigorous sod-binding grasses. It is a heavy producer of roots and crowns.

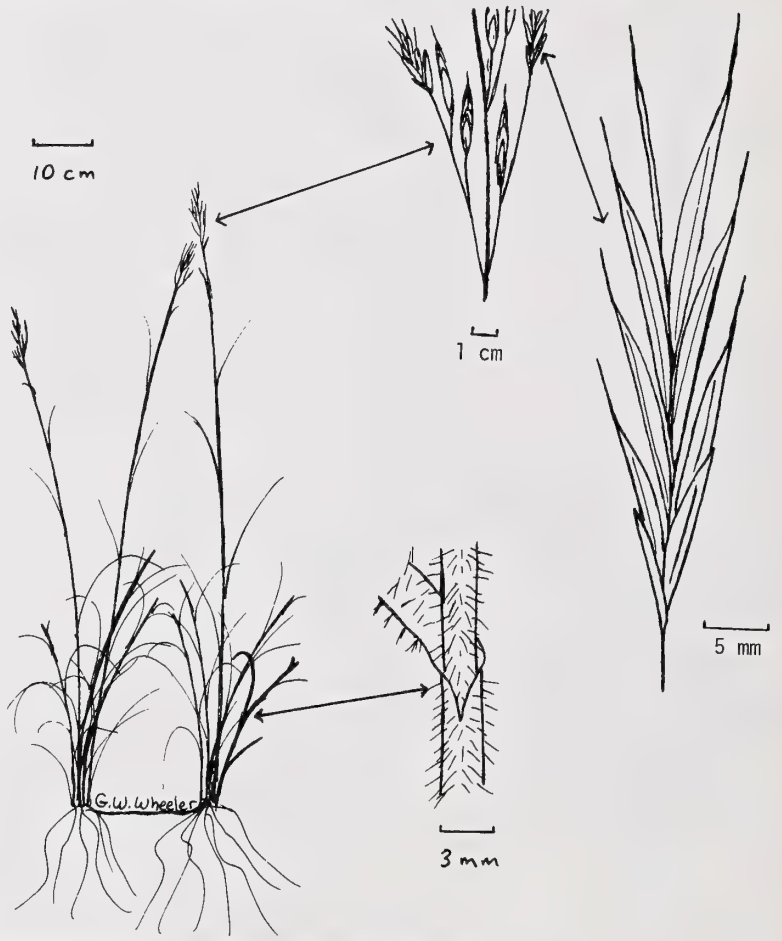

FIGURE 23. Meadow brome grass

The plant has numerous light green leaves that are predominantly basal and mildly pubescent. The seed stalks are from 60-120 cm high and extend above the leaf mass in an open panicle. The plants head and mature 7-10 days earlier than smooth brome grass.

Seeds of meadow brome grass are similar in appearance to smooth brome grass seeds but are almost twice the size and have a much larger awn.

Adaptation — Meadow brome grass is adapted to the same soils and climatic conditions and will grow well wherever smooth brome grass does well. Like smooth

brome, it is also adapted to slightly acid to mildly alkaline soils and has produced good forage yields on dryland and on irrigated land.

It tolerates drought well and is very winter hardy. This grass can be grown in areas with at least 350 mm rainfall annually. Seedlings are vigorous and stands are easy to establish on well prepared seedbeds. It is susceptible to aphid infestations.

Limitations — It can be seeded alone or in mixtures with alfalfa or other legumes. Most of the seed heads appear in the first cutting and only a few seed heads are formed after the first two years. It is slower in establishment relative to smooth brome and is sensitive to spring flooding.

Use for Hay — Grown alone or in a mixture with a legume, meadow brome produces excellent hay. It is very palatable to cattle, sheep, and horses. It is less aggressive than smooth brome and retains a better balance with alfalfa in grass-alfalfa mixtures.

Fertilizer practices that produce good results with other perennial grasses will also produce good results with meadow brome. With irrigation, nitrogen in two applications will produce high forage yields and stimulate the regrowth characteristic of the grass. Nitrogen fertilization under dryland conditions may be beneficial and produce economical returns, especially when yields decline with age of stand.

Use for Pasture — Meadow brome is palatable and well adapted for pasture use. It starts spring growth earlier than most other grasses and is ready for grazing at an earlier date. Its strong regrowth characteristic gives it a good seasonal growth pattern and contributes to its value as a pasture forage.

Animals should not be allowed to graze until the grass is 20-30 cm high. Grazing animals should be removed when there is still 8-10 cm of stubble on the plants. A three to four week regrowth period is necessary for maximum production and longevity of the stand. About 15 cm of regrowth should be allowed in the fall to build up food reserves that will provide early growth the next spring. It can be grown on dryland or with irrigation, alone or with a legume. Solid stands give strong competition to annual and perennial weeds.

Kentucky Blue Grass (Figure 59)

Kentucky blue grass, *Poa pratensis* L., was introduced to North America by early colonists soon after 1600. It is also considered to be native.

Although it is principally used for lawns and pastures in the Prairie provinces, it is an important permanent pasture grass, particularly in western Manitoba and throughout the transition zone between the prairie and the forest in central Saskatchewan and Alberta. In eastern North America, it is considered to be one of the best pasture grasses.

Forage type varieties have been developed specifically for pasture use. They start growth more rapidly in the spring and regrow more quickly after grazing than other varieties of Kentucky blue grass.

Description — Kentucky blue grass is a long-lived, perennial, sod-forming grass. Its leaves are soft, green to dark green, usually 10-30 cm long and boat-shaped at the tip. The stems are 30-60 cm high and usually numerous in a tuft. The seed head is an open panicle. The seeds are numerous and each seed has a mat of cobwebby hairs at its base.

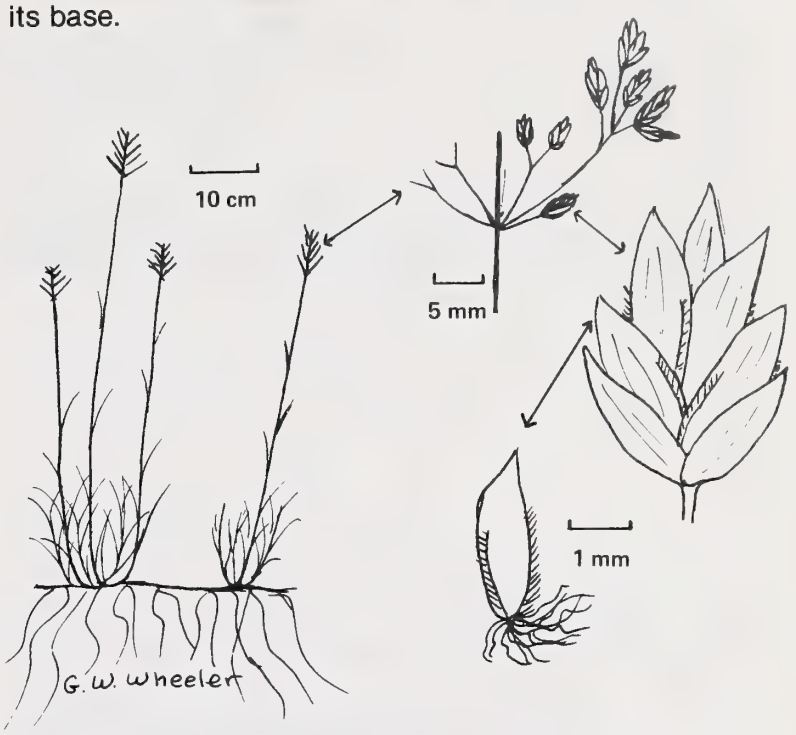

FIGURE 24. Kentucky blue grass

Its shallow root system is extensive and finely branched. In established stands, the mixture of roots and rhizomes in the upper 5 cm of soil forms an extremely dense, resistant sod. The root system is variable in depth, but it is largely confined near the surface of the soil.

Adaptation — It grows best in a cool, humid climate. Although it goes dormant during dry weather, it survives severe drought. Adapted to a wide range of soils, it does best on well drained, highly productive soils of limestone origin. It prefers open sunlight, but it grows in lightly shaded situations if soil moisture and nutrients are favorable. Kentucky blue grass is exacting in its chemical fertility requirements. Large amounts of nitrogen must be available during periods of most active growth, particularly in the spring, early summer, and again in the fall. Phosphorus is also important. The most desirable pH range is 5.8-8.2.

Limitations — It requires more moisture than is generally available in the prairie region. Kentucky blue grass goes dormant during hot, dry weather so that it is relatively unproductive in midsummer. It does well in irrigated areas and midsummer production can be increased somewhat with good fertilization. It lacks tolerance to acidity and salinity.

It is slow getting established. When sown in the spring, little blue grass will be found that year but, once established, it is very aggressive.

Use for Hay — Kentucky blue grass is seldom planted for hay production. Since most growth is in the form of basal leaves it does not generally give heavy yields as a hay crop. However, it is frequently found in hay mixtures as an invader or volunteer.

Use for Pasture — It provides a highly nutritious and palatable pasture under moist, cool conditions. When it is kept actively growing by proper fertilization and stays in the vegetative stage, the protein content remains high throughout the season. When in the blossom or later stages of growth, it is low in protein and high in fibre.

Kentucky blue grass pastures withstand grazing very well and should be kept at a height of 5-15 cm to prevent the sod from becoming weedy and unproductive. If kept extremely short, root and rhizome development is restricted and the pasture becomes unproductive. When underutilized and not mowed, weeds and brush invade it. However, overgrazing or undergrazing blue grass pastures for short periods is not harmful.

In irrigated pasture trials during the summer months, cattle gained more weight on Kentucky blue grass than on orchard grass or smooth brome.

Creeping Red Fescue (Figure 60)

Red fescue, *Festuca rubra* L., is native to North America and Europe. However, a strain of red fescue was introduced to Canada from Czechoslovakia in 1931 and grown at Olds. Selections from the strain resulted in the release of Canada's first variety in 1937.

There are three distinct forms of red fescue that can be distinguished by their creeping habits. The creeping red fescue with 56 chromosomes spreads by strong underground stems. The Chewings fescue type with 42 chromosomes is tufted and does not spread. The foliage is finer textured and the seed culms much shorter than the more robust creeping red fescue. The third type, also with 42 chromosomes, is intermediate in stature between creeping red fescue and Chewings fescue and forms short rhizomes.

Creeping red fescue is used extensively for turf for home lawns, playgrounds, cemeteries, parks, and industrial areas throughout Canada. It is also used to prevent erosion on irrigation ditches and highway and railway rights-of-way, as well as for pastures and soil building.

Description — Creeping red fescue is a hardy, turf-forming grass with a vigorous fibrous root system. It is a long-lived perennial with bright, dark green basal leaves and a reddish lower sheath. Stems are nearly leafless and up to 90 cm long.

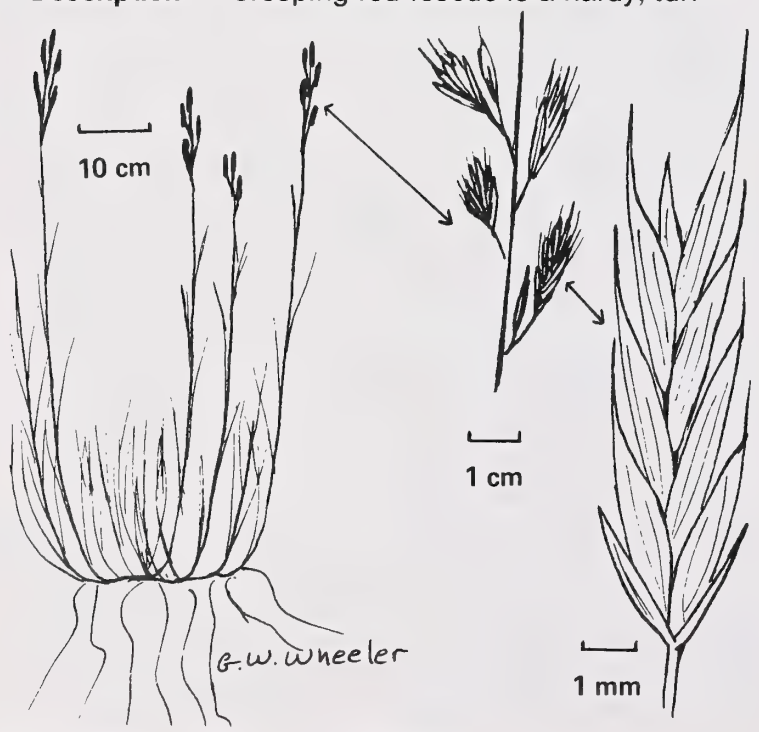

FIGURE 25. Creeping red fescue

Adaptation — Creeping red fescue does best in high rainfall areas. It is, therefore, well suited to Grey Luvisol and some Black soils. It tolerates spring flooding and some water logging, and grows well under irrigation. It is adapted to clay, loam, and sandy soils provided moisture is adequate. It thrives in areas too dry for timothy as it is able to withstand some drought. It tolerates low fertility soils fairly well. It is very tolerant of acidity and somewhat tolerant of salinity.

Limitations — Although creeping red fescue shows some drought tolerance, it is unsuited to Brown and some Black soil areas of Alberta where moisture is a limiting factor. This forage is very susceptible to snow mold which can, in some areas, eliminate a stand. It is also susceptible to winter crown and root rots.

Use for Hay — Creeping red fescue is not well suited to hay production. Hay yields are poor and the low growing plants with basal leaves are difficult to cut. Its quality is similar to that of other grasses.

Use for Pasture — Creeping red fescue is most suited to pasture production and has many of the advantages in moist areas that Russian wild rye has in dry areas. Seedlings are vigorous and readily established. Because of its creeping habit it soon fills in the stand, although not as aggressively as other strongly creeping-rooted grasses like smooth brome grass. It starts growth fairly early in the spring, slows up in mid-summer, and grows vigorously from late summer until freezing. Palatability is only fair but livestock do well on it. It should be grown in a mixture with one or more legumes to improve both yield and quality of forage.

Being low growing, creeping red fescue is very tolerant of close grazing. However, as this tolerance is well known, it is often subjected to overgrazing. This may explain its frequent low yield. Where creeping red fescue has been grazed at correct stocking rates and given adequate time to recover, it has made high-yielding permanent pasture that maintains or even increases in yield over the years.

Creeping red fescue has leaves which retain their nutritive value and green color even after freeze-up, providing grazing until the snow is deep. The quality of mature standing grass is adequate for beef cows on maintenance rations.

Since creeping red fescue is low growing, much of the plant is below the cutting edge of harvesters. This, combined with good regrowth ability, means that hay or seed fields containing creeping red fescue can be grazed after harvest. Moderate grazing after fescue seed harvest increases the seed yield in the following year.

Meadow Fescue (Figure 61)

Meadow fescue, *Festuca elatior* L., was introduced to Kansas in the 1880s from Europe, probably England, where it is a common grass. In Kansas it acquired the name of 'English bluegrass'. It was grown extensively in

Kansas and Missouri and in eastern Canada for herbage and seed. However, it is generally considered a grass of minor importance.

It is a good pasture grass and, to some extent, has been used for hay. It has been used on wetland, but its use is decreasing because of the improvement and increase in the production of tall fescue.

It is similar in some characteristics to tall fescue and, until 1950, tall fescue was considered as a subspecies of meadow fescue. Meadow fescue is shorter growing, has finer leaves, and more shallow roots and is not as long lived as tall fescue. Meadow fescue with 2n = 14, can be distinguished from tall fescue with 2n = 42, by chromosome number.

Description — Meadow fescue is a hardy short-lived perennial with bright green, rather succulent leaves. The predominantly basal leaves are glossy on the under surface. The stems grow from 35-75 cm tall, with leaf sheaths that are smooth and reddish purple at the base. The few stems that are produced have open panicles, similar in appearance to those of Kentucky blue grass. It develops a large number of tough, coarse roots, but it does not propagate by rootstalks or form a very heavy sod. However, it is not as bunchy as orchard grass.

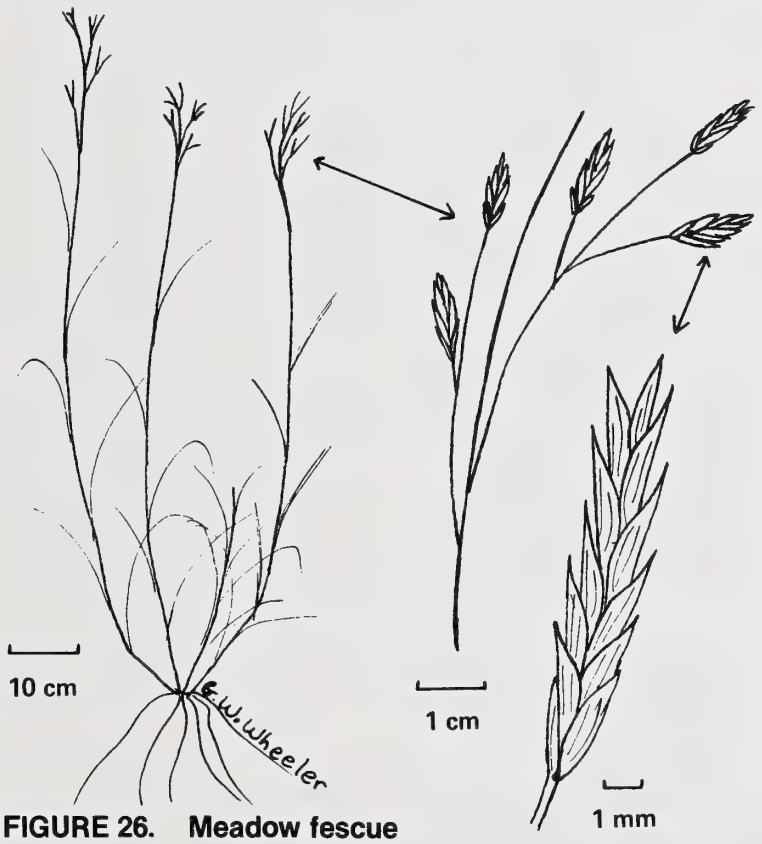

FIGURE 26. Meadow fescue

Adaptation — Meadow fescue prefers a rather heavy, moist soil but, with good care and adequate fertilization, it will do well on light soils or with only a moderate supply of water. It is a fairly hardy grass after it goes through the first winter.

It can be grown wherever timothy is grown, but it withstands more heat and drought than timothy.

It is adapted to moist areas and irrigated pastures. It has been grown for pasture and to a limited extent for hay production, especially on soils that tend to be wet. It plays an important part in soil conservation and has been used in mixtures to prevent soil erosion in waterways.

Limitations — Meadow fescue grows slowly in the seedling stage and usually requires one full growing season to become established. During this time, forage production is low. It suffers from winter injury and is, therefore, low in forage production in the spring.

It will not persist under continuous heavy grazing and needs long periods of rest between grazing. For good forage production, the soil must have high fertility.

Meadow fescue is highly susceptible to leaf rusts and this factor has limited its use, especially in the U.S.A.

Use for Hay — Meadow fescue makes a very good quality hay, but because it produces an abundance of basal leaves, it is recommended primarily as a pasture crop. It grows well in mixtures with other grasses and legumes.

When grown in a mixture and harvested for hay, the meadow fescue aftermath furnishes palatable regrowth desirable for fall pasture.

Use for Pasture — Meadow fescue is best adapted for pasture use. It is ready for grazing early in spring and continues growing late into fall. It makes good late fall pasture which stays green until winter. It will tolerate fairly heavy fall and winter grazing and can be utilized to complement native range in the fall. Because meadow fescue is less palatable than most other grasses, it is generally used in a mixture with legumes since other grasses are grazed in preference to it.

Tall Fescue (Figure 62)

Tall fescue, *Festuca arundinacea* Schreb., was introduced to North America from England in the 1870s and to Canada during the early 1920s. Since its introduction, it has been cultivated for hay and pasture and has spread from fields to wastelands.

The high production potential of tall fescue was first reported in England. It has been used extensively in the U.S.A. and eastern Canada and has become a necessary component of forage crop programs.

It was introduced originally as a cool-season grass crop that would persist through hot summers and cool winters. With the advent of irrigated pastures, it soon became an important, and in many cases, a major constituent of these pastures. Under high fertility and with ample supplies of water, it produces very dense luxuriant growth.

Tall fescue can be distinguished from meadow fescue by its greater height, its broad leaves, and by the deep green upper leaf surfaces which are prominently ribbed and rough. It is longer lived than meadow fescue and has a deeper root system.

Description — Tall fescue is a deep-rooted, long-lived perennial. Essentially a bunchgrass, though it has short underground stems, thick stands will produce an even sod with mowing or grazing. Roots are tough and coarse, and normally penetrate to a depth of at least 150 cm in moist soils.

It has numerous shiny, dark green, ribbed leaves. The branched panicle-type heads are 10-30 cm long and are borne on many to few seed stalks that attain a height of

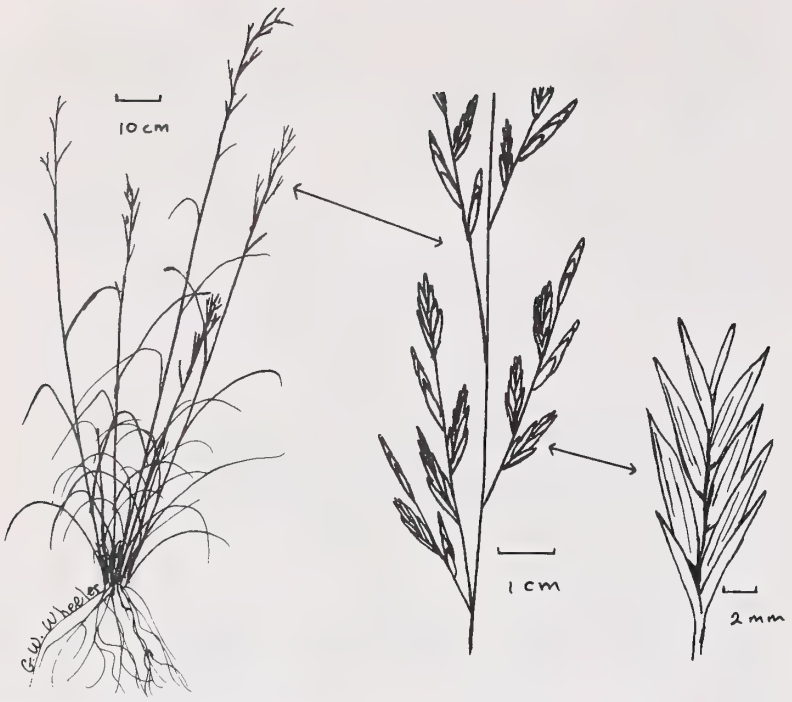

FIGURE 27. Tall fescue

90-150 cm. The seed is similar in size and shape to rye grass, but is somewhat darker in general appearance because of a slight purple tinge.

Adaptation — Tall fescue is adapted to a wide range of climatic conditions, but it makes its best growth under relatively cool growing conditions. It is one of the best grasses available for poorly drained soils in irrigated pastures, and is extensively used as the grass constituent of mixtures in irrigated pastures. Its ability to grow on wet soils, to tolerate alkalinity, acidity, and salinity, and to produce a heavy turf makes it an excellent grass for such sites.

It is one of the more drought-resistant grasses and grows well on dry soils.

The toughness of this grass makes it an ideal cover for airports and playgrounds, as well as on waterways, eroding gulleys, and other areas where a long-lived, tenacious, deep-rooted grass is needed. It is an excellent soil improver, especially on heavy soils, because of the action of the roots in opening up the soil below the 15 cm depth and the large amount of organic matter that accumulates as a result of partial renewal of the root system each year.

Limitations — It is slow to develop in the seedling stage and requires one growing season to become established. It is not completely winter hardy in all areas of Alberta.

Use for Hay — Tall fescue has a limited use for hay since it has a predominance of basal leaves. However, it makes excellent hay and produces good yields when properly fertilized and grown in a grass-legume mixture. For best quality, the grass should be harvested when the first seed heads begin to appear and certainly before flowering. The regrowth after harvesting provides a satisfactory pasture.

Use for Pasture — It is best suited for pasture production and produces most abundantly with irrigation and high fertility. It is a heavy yielder of forage and maintains good production throughout the season. The grass is quite palatable to livestock when the leaves are young and succulent. However, it becomes somewhat coarse, tough, and unpalatable with age. It should be seeded with a legume to improve palatability and nutritive value. It is very aggressive when sown with other grasses.

Although tall fescue has many valuable attributes for pasture use, cattle grazing pure stands may occasionally have nutritional problems. Fescue poisoning or toxicity may affect cattle feeding on it in moist areas during late spring and summer.

Meadow Foxtail (Figure 63)

Meadow foxtail, *Alopecurus pratensis* L., is native to temperate Europe and Asia where it has been widely used as a hay grass for wetlands since 1750. It is not known when the grass was introduced to North America, but it is believed it was in the latter part of the nineteenth century.

It has been confused with several other grasses, especially the weedy ones. However, it is very useful for pasture and hay. It is very similar to creeping foxtail, but has narrower leaves and generally lighter colored seed.

Description — Meadow foxtail is a long-lived perennial grass. It is sod-forming with a few short rhizomes. The growth habit begins as a bunch type, but a dense sod forms with time. The flowering stems are erect and about 90 cm high. The head resembles that of timothy and is easily mistaken for it.

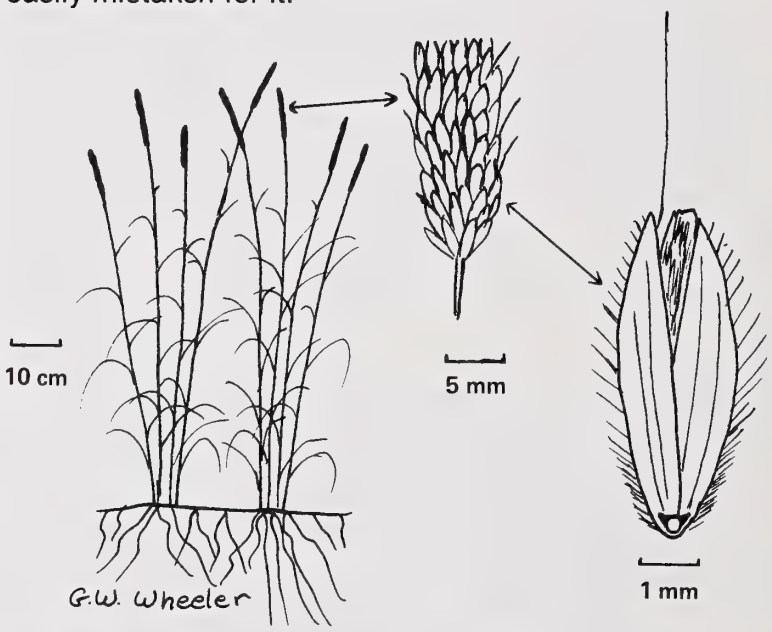

FIGURE 28. Meadow foxtail

The leaves are dark green and numerous. The fluffy seed is normally dark grey.

Adaptation — Meadow foxtail is a hardy grass adapted to the cool moist conditions found in Gray Luvisol soil areas of Alberta. It is second only to reed canary grass in its tolerance to flooding. Its preference for soils with a high water table and cool conditions make it well suited for use on peaty soils. This grass also thrives on clay and loam soils if they are in areas of high rainfall or have a high water table. It is tolerant of alkalinity and is fairly tolerant of acidity.

Although a carefully prepared seedbed is required, it is easily established and gives a full yield the first utilization year. It is very competitive once established and will gradually take over from other forages.

Limitations — The seed is very light and fluffy. This makes harvesting very difficult and, as a result, seed is scarce and very expensive. The light fluffy seed is also very difficult to plant with conventional drills.

Meadow foxtail is intolerant of drought and prolonged periods of very hot weather. It survives but does not produce well in areas with only moderate amounts of moisture or frequent dry spells.

Use for Hay — Meadow foxtail can be used for hay. Lodging is a problem and single cut yields are generally lower than those for reed canary grass or timothy. Although quality is comparable to other grasses at the same stage of maturity, it is early growing and therefore is ready for hay harvesting by mid-June.

Its ability to yield two cuttings in favorable areas with high fertility may prove advantageous. Regrowth after hay cutting is very rapid. This is the best justification for including it in a hay mixture.

Use for Pasture — Meadow foxtail is primarily a pasture grass and, where adapted, produces nutritious and very palatable forage over a long grazing season. Yields are high, especially on well fertilized, properly rotated pastures. Established stands are more or less permanent. Although overstocking weakens the stand by removing most leaf material, meadow foxtail is very tolerant of proper grazing intensities. Livestock should be rotated to another area when plant height is grazed to 10 cm.

Meadow foxtail is the earliest growing domestic grass in the cooler, more moist areas of Alberta. It is often over 15 cm tall and ready for grazing by mid-May. Total growth is well spread over the season. This means it can be grazed first in the spring and rotated for the remainder of the season.

It is well adapted for use in irrigated pasture, especially where water supplies for irrigation are plentiful, but it is not used extensively because of limited seed supplies.

When grown in soft, moist soils, this grass will thicken up by reseeding itself. A mixture can be seeded with shorter-lived forages such as timothy and alsike clover. If grazing is delayed until June, seed will set and fall to the ground. Grazing livestock will press it into the soil and new plants will be established before winter.

Creeping Foxtail

Creeping foxtail, *Alopecurus arundinaceus* Poir., is a perennial grass native to Eurasia. The first introductions arrived in North Dakota in 1902 from the Ukraine and were established in isolated areas. Many of these stands increased and spread naturally. The difficulty of harvesting and sowing the light, hairy seed delayed domestication and use of this species.

The common name 'creeping foxtail' has caused some concern as it is sometimes confused with foxtail barley, *Hordeum jubatum L.*, a weedy grass species. When headed, creeping foxtail resembles timothy.

The grass lends itself to several uses in addition to the traditional one of forage. Its high moisture tolerance and vigorous rhizomes are especially advantageous for controlling erosion along streambanks, shorelines, and waterways, and on earthen dams. The ability to spread rapidly can create maintenance problems if creeping foxtail is planted on banks of canals or ditches. Creeping foxtail resembles meadow foxtail, but has longer, more vigorous rhizomes and wider leaves. It also grows taller than meadow foxtail. Yields of meadow foxtail and creeping foxtail are similar, although meadow foxtail regrows somewhat better late in the season. Creeping foxtail seed is generally black, hairy, and occasionally may have awns.

Description — Creeping foxtail is a long-lived perennial with dense vigorous rhizomes. It forms a dense sod rapidly as individual plants may spread as much as 120 cm in crown diameter in one year. It has dark green leaves and produces an erect seed stalk 75-135 cm tall. The seed

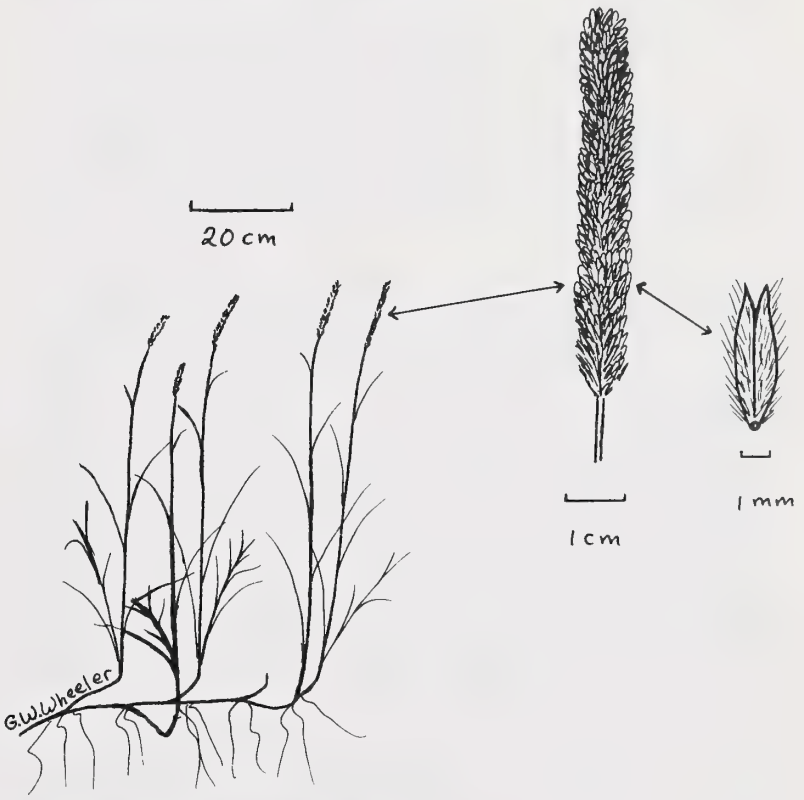

FIGURE 29. Creeping foxtail

head resembles that of meadow foxtail or timothy and is purple during flowering. The flowering begins on the top of the head and proceeds downward. The immature, very light, chaffy seeds change upon ripening through various intensities of grey to black fully matured seeds. Shattering occurs almost immediately after ripening. The black seeds at the top of the head may drop off while seeds at the base of the head are still grey. A high percentage of the seed is black.

Adaptation — Creeping foxtail is adapted to a wide range of soils, provided sufficient moisture is available. It performs well on sands, loam, clay, peat, muck, and gleyed soils. It is tolerant of both moderately acid (pH 5.6-6.0) and moderately alkaline (pH 7.9-8.4) soils and has survived on very wet soils with higher pH. It tolerates salt well.

The grass is adapted to areas where reed canary grass grows well, i.e., in areas with cool temperatures and on sites where soil moisture is continually available. It can withstand flooding for as long as four weeks. It is not drought tolerant or resistant to continuous high tempera-

tures, but it is cold tolerant. This cool season grass makes much of its growth early in the spring, and is one of the earliest of the grasses.

Limitations — Seed of creeping foxtail is light and hairy and, therefore, difficult to plant unless it is properly processed to remove the fine hairs. The seed may be mixed with coarsely cracked grain to prevent bridging in the seeding equipment. Seedlings of creeping foxtail are small and weak after emergence and growth is slow during the first four to six weeks. Thereafter, growth is rapid and rhizomes appear by the eighth week.

The abundance of shattered seed and the prolific rhizomes make creeping foxtail very aggressive. The seed is airborne and waterborne and could cause a problem in waterways.

Good soil moisture is required for germination and emergence. Once established, creeping foxtail requires enough moisture to ensure growth throughout the season. It does not tolerate drought or prolonged dry periods. Nitrogen fertilization is required to maintain production and overcome the build-up of root material in hay or pasture fields.

Use for Hay — Creeping foxtail produces excellent forage but it should be harvested before flowering. With added nitrogen fertilizer, yields of creeping foxtail have been fairly high. It has the ability to regrow following hay harvesting.

It is higher in dry matter digestibility and crude protein content than reed canary grass, and does not lodge as readily as meadow foxtail. It is an ideal grass for old lake beds or sloughs that collect runoff water in spring, as it soon dominates these sites to the exclusion of all but the most competitive native vegetation. Creeping foxtail can also be grown in irrigated areas where it should be seeded with a legume.

Use for Pasture — Creeping foxtail is well suited for use as pasture because it begins growth very early in the season, recovers rapidly from grazing and is not dormant during periods of high temperature in summer, so that growth is evenly distributed. Its palatability is excellent, being preferred over smooth brome grass, reed canary grass, and tall wheat grass. This grass resists grazing very well.

Orchard Grass

Orchard grass, *Dactylis glomerata* L., is a native of Europe but has been grown in North America for over 200 years. It was first cultivated in North America about 1760, and is now common throughout the continent, where it occupies an important place as a cultivated grass for hay and pasture.

It is commonly found growing in shady places such as orchards, which undoubtedly led to its most widely known common name. The characteristic shape of the seed head gave rise to the common name 'cock's-foot', which is used in Europe.

It is a useful cultivated pasture grass in eastern Canada and has shown promise of being a desirable pasture crop, especially with irrigation, in western Canada. Generally it is more digestible and palatable than most other grasses, making it a valuable hay and pasture plant.

Description — Orchard grass is a medium to long-lived perennial bunch grass with a dense, deep fibrous root system. Unless grazed down, it grows in clumps to form tussocks. It produces long, folded, light green leaves most of which are basal. The flowering stems have few leaves and are 90-150 cm high; the flowering head is a tufted panicle 8-15 cm long.

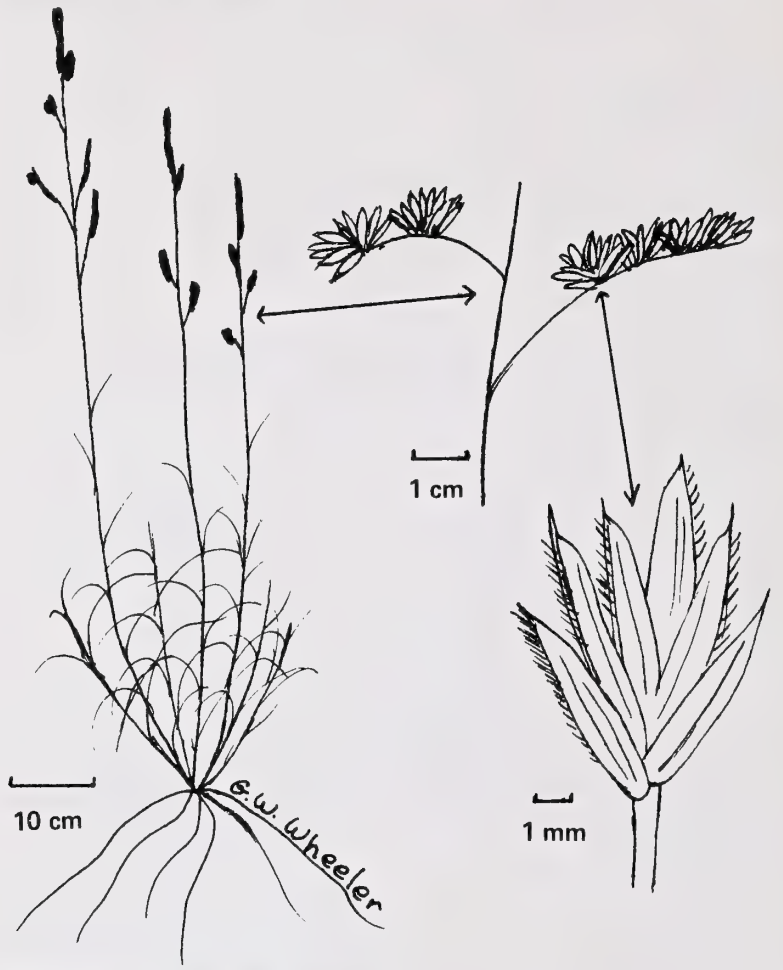

FIGURE 30. Orchard grass

Orchard grass reproduces sexually by seed formation and asexually by tiller formation. Tillering occurs almost continuously and, within a single tuft tillers will be at many stages of development. Under field conditions, the production of new tillers gives orchard grass its perennial character.

Adaptation— This grass is best adapted to the warmer and more moist areas of Alberta. It yields best where precipitation is at least 500 mm per year, and it thrives best on well drained soils. It is very responsive to good management practices, especially those related to high fertility. Orchard grass is somewhat tolerant of acid conditions and is the most shade tolerant of the grasses.

It is more drought tolerant than timothy, but less than smooth brome grass. The drought tolerance is probably related to its extensive root system.

Limitations — In the past, lack of winter hardiness limited the use of orchard grass to the irrigated and chinook areas of Alberta. However, more hardy varieties are being developed and this, along with good fertility, has expanded the area of adaptation into moist areas where winters are more severe.

Orchard grass requires soil with good internal drainage; it thrives in low lying areas only if they are very well drained. This grass tolerates only a moderate amount of salt and does not do well on very alkaline soils. It withstands short periods of drought, but a prolonged dry period will kill it. Sandy soils are generally too dry for good growth, even in areas that receive high rainfall.

Use for Hay — Orchard grass grows tall enough for easy harvesting and a full yield is produced the first utilization year. Although it is aggressive, its bunch habit of growth allows legumes to grow well in mixtures provided the seeding rate is not too high. Regrowth is rapid and it will contribute a good yield on second cutting in alfalfa mixtures.

Use for Pasture — Orchard grass is a preferred pasture forage wherever it is adapted since it grows very rapidly after grazing. It begins growth fairly early in the spring and gives a very high yield and excellent regrowth during the hot summer months when most other grasses grow slowly. Fall growth is good. Most other grasses grow slowly in late summer and fall. In comparison, the rapid regrowth of orchard grass makes it very useful and is a good reason for including it in a pasture mixture. It should be grazed so that seed stalks do not develop.

As it is very palatable, prevention of overgrazing is difficult unless it is fenced separately to permit rotational grazing. Since the main food storage of orchard grass is in the lower stems and leaf parts, it does not tolerate close and continuous grazing. The highest yields of grass and animal production are achieved when livestock are allowed to graze when growth is about 20-25 cm high and taken out when the sward is grazed down to about 10 cm.

Timothy (Figure 64)

Timothy, *Phleum pratense* L., was introduced to North America by seed carried from Europe by early settlers in hay, litter, manure, and ballast cleaned from ships. It was found growing in New Hampshire in about 1711 and was named 'herdsgrass'. It was first given the name timothy in 1747 and soon became an adapted, high quality hay plant. It spread from New England into eastern Canada before 1800, and then westward as the country was settled.

The name timothy covers two species. Turf timothy, *P. bertolonii* DC., originally called *P. nodosum* L., a diploid (2n = 14), is morphologically very similar to common timothy, *P. pratense,* a hexaploid (2n = 42). Turf timothy is more slender and smaller and is used for pastures and as turf for sports fields. Common timothy can be readily identified by its larger size, longer and wider leaf blades and spike-like head, and longer awns.

Description — Timothy is a perennial bunchgrass with shallow, fibrous roots extending downward to about 120 cm. Its crown consists of a group of bulb-like sections called corms. These produce a mass of basal leaves and usually one leafy stem of 50-100 cm that ends in a seed head. All leaves are soft, light green, and 5-15 cm long. The single seed is small, and is enclosed in an awned, urn-shaped husk.

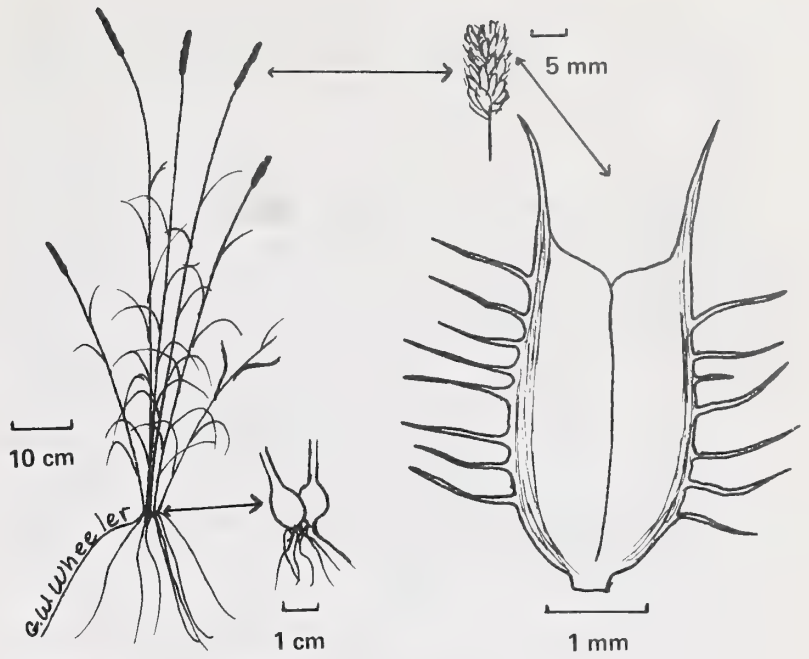

FIGURE 31. Timothy

Individual timothy shoots are typically biennial, but the plant maintains itself as a perennial through the development and growth of new shoots from bases of older culms.

Adaptation — Timothy is adapted to the cooler, moister areas of Alberta, especially the Gray Luvisol soils, where it grows vigorously. As it is very tolerant of acidity, withstands some spring flooding, and does well on water-logged soils, it is well suited for use in low lying peaty areas. Timothy also thrives on clay, silt, and sandy soils provided moisture is adequate.

It is winter hardy, persistent, and fairly free from problems caused by insects, diseases, and other pests. It is widely adapted and can be grown successfully under a wide range of soil and climatic conditions.

Seedling vigor is good and stand establishment usually is rapid. It ranks high in productivity among the grasses.

Limitations — The major limitation of timothy is its low tolerance of drought. It does not tolerate salt or alkalinity so that it is not adapted to sloughs and low lands in many areas of the province.

Its small seed size necessitates very shallow seeding and makes even distribution of seed difficult with conventional drills. Established plants are intolerant of shade and do not withstand lengthy flooding during the growing season. It is susceptible to winter crown and root rots.

It should not be cut or grazed during the two week period before heads emerge as this is a critical stage in the growth of the plant. Removing the top growth at this time greatly weakens the original plants and the cycle of regeneration is interrupted because the buds for the second shoots are not adequately formed.

Use for Hay — Timothy is well suited to hay production. Growth is erect, easy to harvest, and a full yield is normally possible in the first production year after seeding. Because of its bunch growth habit it is less competitive for nutrients when grown in mixtures with legumes. Bunch growth also allows for alternate-row

seeding which makes it ideal for mixtures with alsike and red clover and, in some cases, it is preferred for use with alfalfa.

Its main drawback is the serious loss of quality experienced if it is not harvested for hay before the bloom stage. Growing timothy in mixtures with legumes and harvesting early will overcome this problem. Although timothy is fairly tolerant of low fertility, the application of fertilizer, especially nitrogen, increases both yield and protein.

Timothy has been the standard hay for horses. When cut in full bloom, its high energy and low protein content were ideal for working stock. Its popularity is due to the fact that the grass seldom lodges, and is easily cured into bright, clean hay that is free from dust or mold and which can be handled with little waste.

Use for Pasture — Where adapted, timothy is commonly used for pastures. Spring growth is not too early although yield and palatability are very high. Leafy shoots are of excellent quality. Like smooth brome grass, however, the main growth occurs in early summer and the tall shoots are easily overgrazed. Pasture rotation is critical and a much greater area is required after mid-July to compensate for decreased growth rate.

As a pasture plant, it is relatively short-lived and stands are soon depleted unless provision is made for natural or artificial reseeding. It produces an open sod that is easily weakened if heavily grazed.

Reed Canary Grass (Figure 65)

Reed canary grass, *Phalaris arundinacea* L., is a native plant that is gradually increasing in importance as a cultivated crop. It grows wild in the northern U.S.A. and in Canada where moisture is adequate and the climate is cool. It is found along river banks and sloughs, and it thrives on land with a high water table and land that is flooded for part of the season.

It was valued as a forage crop in Sweden as early as 1749 and in other parts of northern Europe by 1850. Much of the seed used to establish stands in other countries was imported from Sweden. It has been grown in Canada since 1915.

While its natural habitat consists of poorly drained and wet areas, it is known to suffer from winter injury when snow cover is sparse. When irrigated, it is more persistent than other grasses and has been considered a weed as it spreads into irrigation ditches and canals.

Description — It is a tall, coarse, long-lived perennial. It grows in clumps that spread underground by short, scaly rhizomes to form a heavy sod. The deep feeding roots obtain nutrients for a dense cover of long, wide, light green, basal leaves. The stems are 60-240 cm tall. The leafy stems are usually stout enough to prevent lodging.

The brown to grey to grey-black waxy seeds shatter on ripening as they mature from the top of the panicle downward. The seeds resemble flax but are oblong, smooth, and oily.

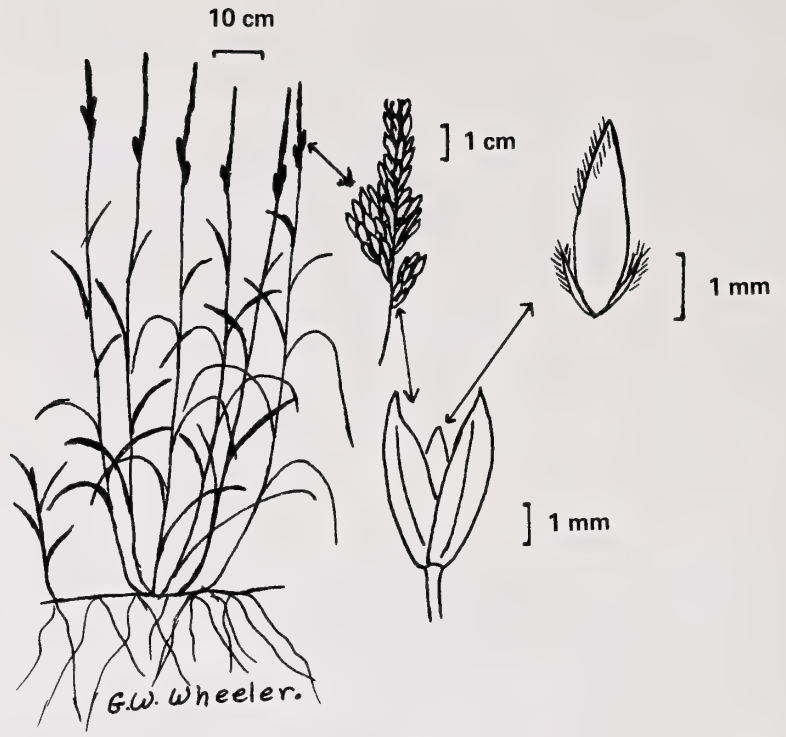

FIGURE 32. Reed canary grass

Adaptation — The ability of this grass to withstand ponding for up to two months, and its tolerance of water-logged soils and moist conditions make it a very useful forage. It also thrives on upland soils in areas with high rainfall. It withstands some acidity and alkalinity, and tolerates drought, although it is not high yielding in dry areas.

Limitations — Seed shattering and problems with the production of seed cause the seed to be in short supply. Seed frequently has a low germination rate and, because of an oily seed coat, is not long lived in storage. Good seed will remain viable for three to four years compared to six to seven years for most other grasses. Although reed canary grass is easily established, sedges and native grasses must be eliminated before seeding low-lying areas. These soils require packing to make a good seedbed. Reed canary grass often requires two years to become fully established. Its main limitation for use in Alberta is its intolerance of soil salinity. For this reason, it is unsuitable for planting in many sloughs. Reed canary grass tends to winterkill when there is a poor snow cover. Its tall growth decreases its usefulness for seeding in mixtures since legumes do not tolerate shade well. The alkaloids present in this grass have been shown to limit animal gains in some instances. Low alkaloid strains exist and are being used to develop new varieties.

Use for Hay — Reed canary grass is exceptionally high yielding for hay. Although it has a reputation for being low in quality, its protein content is comparable to that of other grasses. However, low quality hay is frequently made since reed canary grass is usually grown alone in areas too wet to harvest until late in the season. It should be cut as the heads emerge. Since yields are very high and legumes are not usually included, heavy applications of fertilizer, especially nitrogen, are required. As with smooth brome grass, the addition of adequate fertilizer usually overcomes its tendency to become dense and unproductive.

Use for Pasture — Reed canary grass is very useful for pasture. It starts to grow early in the spring, shows a good distribution of growth throughout the season, gives a high total yield, and regrows well.

The main problem is its low palatability. Therefore, it must be fenced separately giving livestock no alternative but to graze it. As with most unpalatable grasses, its quality as feed is good and livestock produce well when forced to eat it.

Separate fencing also makes the proper stocking rate easy to control. To maintain good quality, reed canary grass should not be allowed to get more than 30 cm high. However, it is intolerant of continued close grazing and should not be clipped shorter than about 10 cm. Controlling the height of reed canary grass makes it possible to include a legume with it except on very moist locations. Regrowth after hay cutting is fairly good and can be used for grazing.

Annual Forages

Annual forage crops can be used to provide emergency or supplementary feed in many areas. Several annual crops can be used to provide supplementary pasture in summer or late fall during periods of drought when perennial pasture production is low, or they can be cut and stored as hay or silage for winter feed. The main crops that have been used successfully are oats, fall rye, barley, spring and winter wheat, corn, peas, Sudan grass, kale, rape, faba bean, sunflower, and Italian rye grass. Sweet-clover and red clover can be used with annuals as well.

Corn has the highest potential yield of any forage crop for silage, especially in Area 1. Corn should be seeded early in the spring, generally near May 1.

Cereal crops, in all areas, should be sown in May or June. Oats generally are superior in total yield to other cereals for hay and pasture. A heavier-than-normal rate of seeding in late May or early June will provide pasture by late July. Oats and fall rye are sometimes used as spring pasture, or if harvested for hay, the aftermath can be grazed until late fall. Fall rye can be used for spring, summer or fall pasture. It is particularly valuable in the spring as it is much earlier than native range. It can be pastured from the time it is 15 cm high (about mid-May) until June 1 and still produce a grain crop if good moisture conditions prevail. Grazing of rye can continue through the summer. Good recovery takes two weeks and this is the best interval for rotational grazing. At the Agriculture Canada Research Station at Swift Current, Saskatchewan, fall rye has been used as a pasture from mid-May to early July with very satisfactory results.

Rye for fall pasture should be planted around August 15. Fall grazing should start after the crop has developed to the point where the ground is well covered. It should not be grazed so heavily that it will leave the ground bare. Fall grazing reduces spring growth and grain yield, whereas spring grazing delays crop maturity.

Spring seeded fall rye produces a mass of leafy growth which is ideal for pasture in late summer or fall. This leafy growth stays green until freeze-up and provides good grazing. If seeded with oats in May or June, the oat seedlings develop faster and will provide earlier grazing. When harvested for hay, the fall rye makes a good recovery after cutting while the oats yields a large first cut and recovers slowly.

Rye pasture should be used mainly for beef cattle as it taints milk. A danger with fall rye pasture is grass tetany or grass staggers, which results in muscle stiffness and loss of coordination in grazing animals. This is associated with lush-growing forages on land that has been heavily cropped or heavily fertilized. Adding magnesium to the fertilizer or the feed will overcome the problem.

Fall rye makes acceptable silage if cut in the early dough stage. A good silage is obtained when seeded with sweet-clover. If cut late, the hay is usually of low quality and is also slippery, hard to handle, and difficult to cure.

Cover crops, originally used to prevent soil drifting in southern Alberta, are now grown extensively for fall finishing of beef cattle in the foothills area. Oats seeded during the last half of July forms the most satisfactory cover crop. Cattle are moved in when the oats are 30-40 cm high.

Pasture rape has proven useful in Alberta as a pasture for sheep. It grows quickly, is ready for grazing in six to seven weeks, and provides good animal gains.

Sudan grass is a summer annual that can be used for midsummer pasture, greenfeed, silage, or hay in Area 1. The crop usually makes better pasture than hay. When used for pasture, Sudan grass fields should be divided into paddocks and grazed in a rotation so that each paddock is rested about four weeks between grazings. It should not be grazed until the plants are about 40 cm high. There may be a potential danger of hydrocyanic (prussic) acid poisoning from grazing Sudan grass.

Sorghum and sorghum-Sudan grass hybrids have an advantage for short-term grazing in Area 1, as they are drought tolerant. They are warm season crops but are unsatisfactory for silage because of the high moisture content at the end of the growing season. Sorghum can be planted later than corn and it is ready for grazing in about eight weeks. As with Sudan grass, there is a potential danger of hydrocyanic acid poisoning, especially if grazed immediately after a period of slow growth.

Millet is used primarily for temporary summer pasture in Areas 1 and 2 as it produces hay and silage of inferior quality. It should be seeded by July 15 if moisture conditions are favorable. Compared with Sudan grass, millet is coarser, is slightly less palatable to livestock, produces forage of slightly lower quality, and is less tolerant of severe drought. It should not be grazed until it is about 50 cm high and should be grazed in rotation, preferably in four fields.

Italian rye grass is a short-lived perennial but it can be used as an annual if seeded in the latter part of April on irrigated land. It generally lacks the hardiness to survive overwinter. With good fertility and adequate irrigation, it can provide grazing for livestock from mid-June until late September. Under dryland conditions, Italian rye grass does not do as well as some of the other crops unless annual precipitation is more than 450 mm.

Regional Adaptation

Climatic and soil conditions determine where forages can be grown. Consequently, there is a kind and variety of forage crop best suited to every location and soil type. However, in this section only the forage crops in common use are included. It is important that the right kind and variety be chosen for a particular area if maximum production is to be achieved. For specific recommendations see *Varieties of Hay and Pasture Crops for Alberta.* This publication is revised annually by the Alberta Forage Crops Advisory Committee. The map of the province shows the major soil climatic areas. (See below.)

FIGURE 33. Major soil climatic areas of Alberta

Area 1 — Brown Soil Zone

This is the driest part of the province. Therefore, drought-tolerant species are recommended. Regular rotations of grain and forage are rarely followed in Area 1. With low rainfall, fibre decomposes slowly. Good tilth can be maintained by incorporating all crop residue in the soil. Forages contribute to erosion control and should be used exclusively in some situations.

Russian wild rye, Altai wild rye, and crested wheat grass can increase carrying capacity of higher potential range sites of Area 1. By reseeding abandoned crop land and overgrazed native range to these grasses, increased production can be realized.

In a 10-year study at the Agriculture Canada Research Sub-station near Manyberries, sheep gains on crested wheat grass and Russian wild rye pastures, respectively, were 2.6 and 3.2 times those on native range. In a subsequent 6-year study, gains by yearling steers on a Russian wild rye pasture seeded in 45 cm rows were six times those on native range.

The use of crested wheat grass as complementary pasture to the native range at Swift Current, Saskatchewan, increased beef production. A system with a ratio of about 20 percent of crested wheat grass to 80 percent native range produced 75 percent more beef than native grass alone. Russian wild rye can be used with even better results.

Crested wheat grass can be left down permanently in this region. At Manyberries, crested wheat grass seeded in 1928 is still productive. It produced its highest yield in its thirty-seventh year – when moisture was very favorable. It yields, on the average, about twice as much forage as native rangeland.

Alfalfa mixed with either crested wheat grass or Russian wild rye will further increase carrying capacity.

Area 2 — Dark Brown Soil Zone

Better moisture in Area 2 allows for greater use, and a wider choice, of forage crops. Crested wheat grass, Russian wild rye, Altai wild rye, sweet-clover, and alfalfa are suitable in the drier sections. In districts of more plentiful moisture, alfalfa, brome grass, pubescent and intermediate wheat grasses, and timothy may be grown to advantage. Throughout Area 2, more use can be made of sweet-clover and alfalfa.

Where forage crops are included in grain-grass rotation, they should remain down from three to seven years.

Area 3 — Black Soil Zone

Because of the good fertility and adequate moisture conditions in Area 3, forage crops provide extensive pasture and hay to meet the livestock needs of a mixed farming economy.

Alfalfa and brome grass are the most useful forage crops, but all winter-hardy grasses and legumes can be grown successfully. Alsike and red clovers, timothy, and creeping red fescue are all frequently used.

Area 4 — Gray Luvisol Soil Zone

On the Gray Luvisol soils in this area, forage crops are especially important for soil improvement. The use of legumes will increase subsequent grain yields. Grasses are also essential, since these soils contain low amounts of organic matter. Therefore, if grain crops are grown they should be used in rotation with forage crops. Alfalfa, alsike and red clovers, brome grass, timothy, and creeping red fescue are important forage crops in this area.

In improving Gray Luvisol soils, legumes and fertilizer should be used together. Forage yields in this area are often more than doubled by fertilizer application. Yields of grain usually show marked increases after growing fertilized legumes.

Nitrogen, phosphorus, and sulphur are the elements usually lacking. Nitrogen can be supplied by growing legume crops but phosphorus and sulphur must be supplied in the form of commercial fertilizer.

Fort Vermilion Area

In this area rainfall is variable and lengthy periods of drought occur. Brome grass, creeping red fescue, and alfalfa are well adapted. Crested wheat grass and other dryland species are useful on light soils. Timothy, alsike clover and red clover are satisfactory on soils with higher amounts of moisture.

Irrigated Areas

Irrigation makes the use of a wide range of forage crops possible.

Much of the economy of irrigated areas lies in the production of cash crops, which are grown in a rotation system with forage crops. Alfalfa provides the main feed source for livestock and acts as the best soil conditioner for subsequent crops.

Alfalfa is the main hay crop on irrigated land but brome grass and orchard grass are used extensively. Tall wheat grass, reed canary grass, and tall fescue play an important role in land reclamation on irrigated farms.

Forage Seeding Rates

Seeding Rates for Pure Stands

Table 1 shows approximate seeding rates for single species grown for fodder use.

Although a combination of grasses and legumes is more frequently seeded, the table is useful for composing specific mixtures. The percentage of each species desired in the mixture should first be determined. Then the quantity of seed required to seed a pure stand can be used as a guide for determining the amounts of each species required.

Table 1 — Seeding Rates for Forages

Crop	Approx. No. of Seeds/kg	Seeding Rate kg/ha to provide 80 seeds/m of row in 15 cm row Spacing	Usual Seeding Rate kg/ha ROW SPACING 15cm	30cm	60 cm	90cm
LEGUMES						
Alfalfa	440,000	10	9	5.5		
Sweet-clover	572,000	8	9	5.5		
Alsike clover	1,540,000	3	5.5	—		
Red clover	605,000	7	7	4.5		
White clover	1,760,000	2.5	4.5	—		
Bird's-foot trefoil	825,000	5	9	7		
Sainfoin	66,000	65	35	20	10	
Cicer milk-vetch	286,000	15	14	9		
Crown-vetch	242,000	18	15	9		
GRASSES						
Russian wild rye	385,000	11	—	5.5	3.5	2.5
Altai wild rye	112,000	38	—	13.5	9	4.5
Crested wheat grass	385,000	11	—	5.5	2.5	
Northern wheat grass	340,000	13	8	6	4	
Western wheat grass	242,000	18	11	7	3.5	
Intermediate wheat grass	194,000	22	11	7		
Pubescent wheat grass	220,000	20	11	7	5	
Slender wheat grass	350,000	12	9	6		
Streambank wheat grass	344,000	12	9	6		
Tall wheat grass	174,000	25	13	10		
Perennial rye grass	500,000	8.5	9	6		
Italian rye grass	500,000	9	9	6		
Kentucky blue grass	4,800,000	0.9	7	5		
Smooth brome grass	300,000	14	9	6		
Meadow brome grass	176,000	24	12	7		
Creeping red fescue	1,353,000	3	5.5	3.5		
Meadow fescue	506,000	8.5	9	6		
Tall fescue	500,000	8.5	8	5		
Meadow foxtail	1,270,000	3.5	6	3.5		
Creeping foxtail	1,657,000	3	5	3		
Orchard grass	1,439,000	3	6	4		
Timothy	2,710,000	1.6	5	4		
Reed canary grass	1,175,000	3.5	6	3.5		

Mixtures of Grasses and Legumes

Mixtures of a grass and a legume are often better than single species stands. Mixtures are recommended for hay and pasture use throughout the province. However, mixtures do not need to be complex. The use of one legume and one grass, if well adapted to the environment and intended use, will frequently give maximum yield. Some legumes perform best when seeded alone and, for some uses, a single legume gives superior performance. Table 2 gives several mixtures which are adapted and recommended for use on well drained typical soils in Alberta. Special purpose mixtures for problem soils are not included. For information on variety selection, reference should be made to the publication, *Varieties of Hay and Pasture Crops for Alberta* which is revised annually.

Recommended Crops and Mixtures

Table 2 — Seeding Rates for Mixtures

Area and row spacing	Crops	Approximate seeding rate[1] (lb/ac or kg/ha) Hay	Pasture
1. BROWN SOIL ZONE[2]			
24-36 in (60-90 cm)	Altai wild rye + alfalfa	—	4+1 to 2*
18-24 in (45-60 cm)	Russian wild rye + alfalfa	—	3+1 to 2*
18-24 in (45-60 cm)	Crested wheat grass + alfalfa	4+2	4+1 to 2*
18-24 in (45-60 cm)	Alfalfa	4	—
12-18 in (30-45 cm)	Smooth brome grass + alfalfa (moister parts)	7+2	7+1 to 2*
12-18 in (30-45 cm)	Pubescent or intermediate wheat grass + alfalfa (moister parts)	8+2	8+1 to 2*
2. DARK BROWN SOIL ZONE[2],[3]			
18-24 in (45-60 cm)	Altai wild rye + alfalfa	—	6+1 to 2*
12-18 in (30-45 cm)	Russian wild rye + alfalfa	—	5+1 to 2*
12-18 in (30-45 cm)	Crested wheat grass + alfalfa	5+2	5+1 to 2*
12-18 in (30-45 cm)	Smooth brome grass + alfalfa	7+2	7+1 to 2*
12-18 in (30-45 cm)	Pubescent or intermediate wheat grass + alfalfa	8+2	8+1 to 2*
12-18 in (30-45 cm)	Alfalfa	5	—
12-18 in (15-30 cm)	Sweet-clover	8	—
3. BLACK SOIL ZONE[2]			
6-8 in (15-20 cm)	Smooth brome grass + alfalfa	6+5	8+1 to 3*
6-8 in (15-20 cm)	Crested wheat grass + alfalfa	5+4	7+1 to 3*
6-8 in (15-20 cm)	Intermediate wheat grass + alfalfa	7+5	9+1 to 3*
6-8 in (15-20 cm)	Meadow brome grass + alfalfa	—	10+1 to 3*
6-8 in (15-20 cm)	Creeping red fescue + smooth brome grass + alfalfa	—	2+6+2 to 3*
6-8 in (15-20 cm)	Orchard grass + alfalfa	—	6+1 to 3*
6-8 in (15-20 cm)	Timothy + smooth brome grass + alfalfa (moister parts)	2+6+5	2+7+2 to 3*

Recommended Crops and Mixtures

Area and row spacing	Crops	Approximate seeding rate[1] (lb/ac or kg/ha) Hay	Pasture
6-8 in (15-20 cm)	Meadow or creeping foxtail + alsike clover (moist and flooded sites)	4+4	5+2
6-8 in (15-20 cm)	Alfalfa	8	—
6-8 in (15-20 cm)	Sweet-clover	9	—
6-8 in (15-20 cm)	Bird's-foot trefoil (moister parts)	6	6
6-8 in (15-20 cm)	Meadow foxtail or creeping foxtail (moist and flooded sites)	5	5
4. GRAY-LUVISOL SOIL ZONE[4]			
6-8 in (15-20 cm)	Smooth brome grass + alfalfa	6+5	8+1 to 3*
6-8 in (15-20 cm)	Meadow brome grass + alfalfa	—	10+1 to 3*
6-8 in (15-20 cm)	Intermediate wheat grass + alfalfa	7+5	9+1 to 3*
6-8 in (15-20 cm)	Creeping red fescue + smooth brome grass + alfalfa	—	2+6+2 to 3*
6-8 in (15-20 cm)	Creeping red fescue + intermediate wheat grass + alfalfa	—	2+6+2 to 3*
6-8 in. (15-20 cm)	Creeping red fescue + timothy + alsike (moist and flooded sites)	3+3+2	3+2+2
6-8 in (15-20 cm)	Reed canary grass + alsike (moist and flooded sites)	4+4	6+2
6-8 in (15-20 cm)	Timothy + alfalfa + red clover	4+2+3	—
6-8 in (15-20 cm)	Timothy + alsike	4+4	—
6-8 in (15-20 cm)	Meadow or Creeping foxtail + alsike clover (moist and flooded sites)	4+4	5+2
6-8 in (15-20 cm)	Alfalfa	8	—
6-8 in (15-20 cm)	Sweet-clover	9	—
6-8 in (15-20 cm)	Bird's-foot trefoil	6	6
6-8 in (15-20 cm)	Meadow foxtail or creeping foxtail (moist and flooded sites)	5	5
5. IRRIGATION			
6-8 in (15-20 cm)	Alfalfa	10	—
6-8 in (15-20 cm)	Sainfoin	35	35
6-8 in (15-20 cm)	Orchard grass + meadow brome grass + white clover	—	6+8+2
6-8 in (15-20 cm)	Orchard grass + alfalfa	4+8	8+2 to 3*
6-8 in (15-20 cm)	Smooth or meadow brome grass + alfalfa	8+5	10+2 to 3*
6-8 in (15-20 cm)	Intermediate or pubescent wheat grass + alfalfa	12+5	12+2 to 3*
6-8 in (15-20 cm)	Kentucky blue grass + alfalfa	—	10+2 to 3*

[1] *Increase seeding rates by about one-half when seeding grass alone or if broadcasting the seed.*

[2] *Cicer milk-vetch at 5-6 lb/ac (or kg/ha) can be substituted for alfalfa in the pasture mixtures.*

[3] *Sainfoin at 10-15 lb/ac (or kg/ha) can be substituted for alfalfa in the pasture mixtures.*

[4] *Mixtures containing sweet-clover are useful on poorly structured Gray Luvisol soils where crusting and compaction occur.*

[5] *Higher seeding rate of alfalfa component is advantageous for yield and quality but may require the use of bloat control measures.*

Seeding Practices

Seeds of different varieties look alike and varieties cannot be identified on the basis of seed characteristics. Many new varieties are selected for specific performance or disease resistance. In order to be confident of the purchase, obtain pedigreed seed. Varietal purity is guaranteed and the seedlot will be reasonably free from weeds and diseases. Choose the variety that is adapted to the area. (Refer to the publication *Varieties of Hay and Pasture Crops for Alberta,* published annually, for latest recommendations.)

Seedbed Preparation

A firm, clean seedbed, with the surface sealed to provide good moisture retention is desirable. Some packing is usually required to prevent the seedbed from drying out quickly and to ensure that the seed will be in contact with the soil for good germination. Clean fallow land is suitable after packing.

In areas where soil drifting is a problem, some form of protection must be provided for the seedlings. This is best accomplished by seeding into clean, undisturbed grain stubble. Where stubble is not available, a light seeding of oats will provide protection.

For heavy-textured Gray Luvisol soils where crusting is a problem, packing should be avoided. For these soils, a cloddy seedbed and increased rates of seeding have proven beneficial.

The seeding of forage crops directly into sod is usually disappointing. Thorough breaking and subsequent cultivation are required to eliminate all plant competition.

Companion Crops

In general, companion crops are not recommended as they provide too much competition for the forage seedlings. They reduce the vigor and increase the mortality of the forage seedlings. However, under drifting or eroding conditions and in high rainfall areas, they can be used successfully. Where used, the companion crop—flax, wheat, oats, barley, or rapeseed seeded at half the usual rate, is planted in a separate operation, preferably crosswise or in alternate rows to the forage crop. The crop and crop residues should be removed as early as possible.

Weeds are frequently a problem if a companion crop is not used. These may be controlled by clipping or by spraying with chemicals. All grasses beyond the three-leaf stage are tolerant of 2,4-D amine. Embutox E is a common herbicide used on alfalfa, white clover and bird's-foot trefoil. Tropotox Plus is another common herbicide which can be used for weed control on red clover, alsike clover and sainfoin. Manufacturer's recommendations should be followed regarding use and rates of application.

Inoculation

Legumes are unique in their ability to utilize atmospheric nitrogen because of their symbiotic association with the rhizobia root-nodule bacteria. This association of a legume with its appropriate rhizobium can supply most of the total nitrogen for the plant, thus reducing fertilizer and soil nitrogen consumption. Legumes must always be correctly inoculated with the proper inoculum since the rhizobia present in the soil may not be specific to the legume grown and those already present in the soil have often lost their nitrogen-fixing ability.

Peat-based and granular inoculants together with sticking agents are available commercially at moderate cost. The inoculum must be stored at a cool temperature (4 °C), preferably refrigerated, and must be protected from sunlight. It must not be used past the expiry date. Inoculum should be applied to the seed using an appropriate sticking agent immediately before seeding and should be shielded from direct sunlight until planted. Commercial sticking agents or 10 percent sugar or syrup solutions with skim milk can be used. If seeding is delayed by rain or a breakdown, the seed may be stored in a cool, dark place for a few days. However, if extra inoculum is available, the seed should be re-inoculated just before seeding gets underway again. Applying dry inoculum or application as a slurry in water does not give satisfactory results.

The inoculated seed should be sown in a moist seedbed at the recommended seeding depth. Serious losses in the number of bacteria will occur if inoculated seed is planted in dry soil. If inoculated seed is broadcast, it should be harrowed or otherwise covered as soon as possible.

The success of the inoculant can be evaluated by removing some legume roots and noting the number and size of the nodules. A pink to red coloration of the nodules when squeezed indicates active nitrogen fixation; white nodules are not active.

Pre-inoculated seed is available from some firms. The pre-inoculated seed eliminates the extra time and effort required to apply inoculants, but has a major disadvantage in that the viability of rhizobia declines after it is applied to the seed. Also, it is more difficult to keep large lots of pre-inoculated seed under suitable storage conditions.

Time to Seed

Seeding to coincide with favorable moisture conditions is the most important factor in establishing forage stands. In general, successful seedings can be made at three different times of the year.

Spring Seeding

In Areas 1 and 2, forage seeding should be early to take full advantage of spring moisture. Throughout Areas 3 and 4, seeding of forage is most successful in spring, but it can be done as late as mid-June.

Early Fall Seeding

In Area 1 and the southern half of Areas 2 and 3, early fall seeding is often suitable for all forage crops except alfalfa and sweet-clover. These legumes seeded at this

time will usually winterkill. Early fall seeding is hazardous during severe outbreaks of grasshoppers and should not extend beyond September 15. In central Alberta, early fall seeding should be completed by August 15.

Late Fall Seeding

Seeding forage crops after October 15 until freeze-up helps to ensure germination early the next spring so that the young seedlings can take full advantage of moisture from the winter snowfall. The seeds will not germinate in the cold soil in late fall, and are essentially being stored in the ground for emergence the next spring when the soil warms up. With the exception of sweet-clover, most grasses and legumes germinate well from late fall seeding. This method is used mostly in areas subject to spring flooding and peaty areas that remain wet during summer. Since winter winds can remove seed from unprotected soil, seeding into the soil, preferably with a cover of stubble or dead weeds, is recommended.

Depth of Seeding

Depth of seeding is important. An emerging seedling is dependent on the food reserves in the seed for growth until green leaves develop. After this, the plant supports its own growth through photosynthesis. Because most forage seeds are small, they do not contain sufficient food reserves to support growth from deep within the soil. Small seeds, such as alsike clover, bird's-foot trefoil, and timothy, therefore, must be seeded shallowly, preferably less than 1 cm deep. Larger seeds may be seeded up to 2 cm deep.

A grain drill is satisfactory for seeding forage crops and special adaptations are available to improve its use. One of the most useful adaptations is a flange or band attached to the discs to prevent seeding too deep. (See Figure 66.) The main drill box can be used if a filler, such as cracked wheat, is mixed with the seed to maintain constant flow. Broadcasting and harrowing are successful in areas with good moisture conditions. Forage seeders are available and are very satisfactory under special conditions.

Pasture Management

Good pasture management involves much more than simply turning stock onto forage. The ultimate purpose of pasture is to convert forage into a saleable animal product. To get maximum animal production, the needs of the animal must be understood as well as those of the plant and the interaction of one upon the other.

Many factors contribute to production. Good pasture management involves the control and application of these factors for maximum production.

Factors Affecting Production

Stage of Growth

The stage of maturity of the pasture plant is one of the most important factors determining animal consumption and utilization. During the early vegetative stage, plants are highly nutritious, palatable, and most digestible. In addition, the rate at which they are digested is highest. During the early vegetative stage, plants are relatively uniform and, provided plants are at least 10-15 cm high, their consumption by animals is at a maximum. (See Figure 67.)

As the plant matures, its nutritive value declines, it becomes less digestible, and it is less palatable. The plants become less uniform and the animals graze selectively. Consequently, the animals consume less and what they do consume is not as nutritious. The net result is lower production of animal products—meat, milk, and wool.

We must also consider the health and nutrition of the plant and its ability to provide an abundance of feed. Plants must be allowed to establish some growth, otherwise they become weakened and the rate of growth will decline. The compromise between animal and plant needs is to allow about 15 cm of growth before grazing and to graze in the pre-bloom stage.

Mixtures

Greater quantities of forage are generally produced when legumes and grasses are grown in a mixture than when either is grown alone. Even in the driest part of the province, adding alfalfa or another legume to grasses will increase production. Moreover, legumes are high in protein so their inclusion increases the nutritive value of the pasture.

Grass and legume mixtures should be used wherever possible. Grasses mixed with legumes lessen the danger of bloat. Maintain the legume at no more than 50% of the stand or plant legumes that do not induce bloat.

Field Uniformity

Animals will graze selectively and certain areas will become overgrazed while others may be undergrazed. Where topography or soils vary greatly, it may not be possible to overcome this problem completely. A proper system of rotational grazing normally eliminates this problem. Also, it may be possible to reduce variability by careful arrangement of fence lines.

Stocking Rate

The number of animals grazing a pasture is a factor that must be given high priority in the management program. Since the purpose of pasture management is to

convert forage to meat, it follows that there must be enough animals to use the forage produced. Any carryover is usually associated with waste and is believed to detract from efficient production.

However, the interrelation of plant and animal must be considered. To maintain maximum plant production, some carryover must be left at the end of the grazing period. Overuse will weaken the plants and regrowth will be correspondingly slower. Carryover should be limited to that necessary for quick recovery of plant growth. A good rule-of-thumb is to leave 8-10 cm of aftermath.

Adjusting the number of animals to the pasture is not an easy matter because plant growth is not uniform throughout the growing season. Figure 34 illustrates the change in rate of plant growth through the season. How then can an operator avoid overgrazing during periods of slow growth, and wastefulness during periods of rapid plant growth? He must be prepared to harvest surplus production as hay or silage during periods of rapid plant growth. He must provide extra pastures or feed hay or silage when pasture growth is slow. Cutting and feeding hay on pastures is a normal practice in good pasture management. The use of rotational or strip grazing will facilitate this practice.

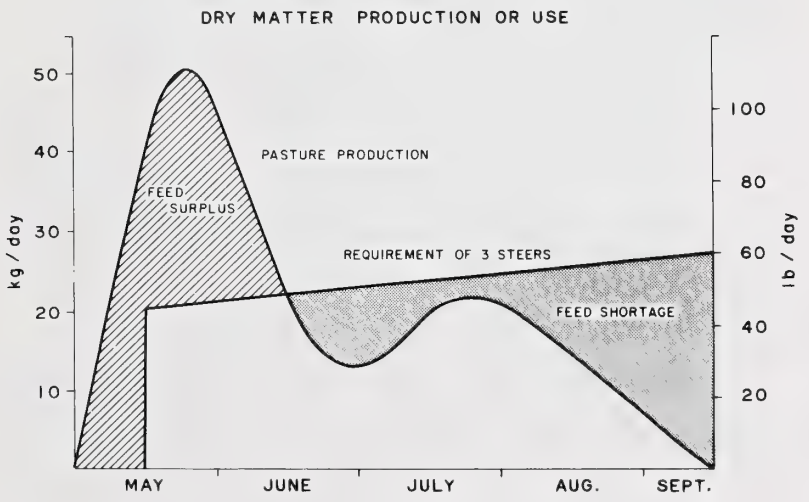

FIGURE 34.
Forage production is not uniform throughout the season — yet the animals' daily requirements increase. Graph applies to irrigated areas only.

In areas where moisture permits good regrowth, forages can be harvested for hay with regrowth used to increase pasture supplies in fall. The use of fertilizer increases regrowth.

Other Treatments

Many details in pasture management may appear to be of minor importance in themselves, but in total they have an important bearing on the carrying capacity of the pasture.

Harrowing occasionally to spread droppings reduces loss from fouling, and benefits the forage with the nutrients in the manure.

Clipping grasses at 8-10 cm height before heading will stimulate regrowth and increase palatability.

When forage stands become thin or weedy, it may be necessary to break them up and reseed. If a regular crop rotation is followed, forage crops do not remain down long. This practice is recommended in many mixed farming situations.

Weed control should be a regular practice in pasture management. Perennials such as Canada thistle can become a serious problem in pastures because livestock do not eat them. Mowing will help to control these weeds. Herbicides are also effective but should not be applied on pastures currently in use. (Refer to the publication *Weed Control in Forage Crops* for more details.)

Careful arrangement of fences to provide for lanes and easy access to shade and water and a convenient layout should be part of any pasture program. The fencing should take into consideration the source and location of the water supply, the location of handling facilities in relation to the fields, roads and farm site, and the availability of shade in the fields.

Gophers and pocket gophers should be controlled as they reduce yields and their burrows are a hazard to stock.

Grazing Systems

Putting all the factors affecting pasture production into practice can be difficult unless a grazing system is adopted. For instance, chemical control of weeds is generally not recommended on pastures currently in use. Unless there is a system that occasionally removes the stock, this method of control cannot be used. Similarly, it is difficult to control stage of growth at grazing, and to harvest surplus as hay, under a system of continuous grazing. The choice of system that best meets the circumstances on the individual farm should be considered carefully.

A successful grazing system ensures a high level of cattle performance at minimum costs while improving the productivity of the pasture. A successful system on one farm may not be effective on other farms, but these systems have some key factors in common. These factors are production of high quality pasture for the entire grazing season, and meeting the cattle feed requirements throughout the grazing season.

Continuous Grazing

In this system, stock are turned onto pasture and remain there throughout the season. It is best suited to areas of low productivity such as native range or cultivated pastures in the drier parts of the province. Where continuous grazing is practised, the stocking rate should be sufficiently low to ensure a carryover of forage. Provision for emergency pasture, possibly with annuals, should be made to allow for abnormally dry years.

Rotational Grazing

This system involves dividing the field into separate pastures, each of which is grazed separately and in turn. In areas of good production, it will give the operator more control and will permit fuller use of the forage. It also permits efficient use of various soil types requiring

different pasture mixes. Each pasture should be grazed down to a carryover of 8-10 cm.

In years of good moisture, surplus production can be cut for hay or silage. This is accomplished by taking one pasture out of the grazing rotation and using it for hay or silage and then putting it back in rotation when regrowth permits. In seasons of poor production, all pastures are used for grazing to support the herd. Thus rotational grazing provides flexibility and the operator can adjust stocking rate to the varying seasonal forage production.

Increased production results from rotational grazing because each pasture area is grazed off quickly, at the proper stage, then allowed a regrowth period of two to four weeks. Figure 35 shows the approximate rate of growth on irrigation, during high production periods after the plant has been clipped by the animal. Note that during the first six to eight days, rate of regrowth is relatively slow and that the rate increases subsequently. This is because immediately after grazing the plant has very little leaf area with which to manufacture plant tissue (growth). As the leaf area increases, so does photosynthesis and thus the rate of growth accelerates.

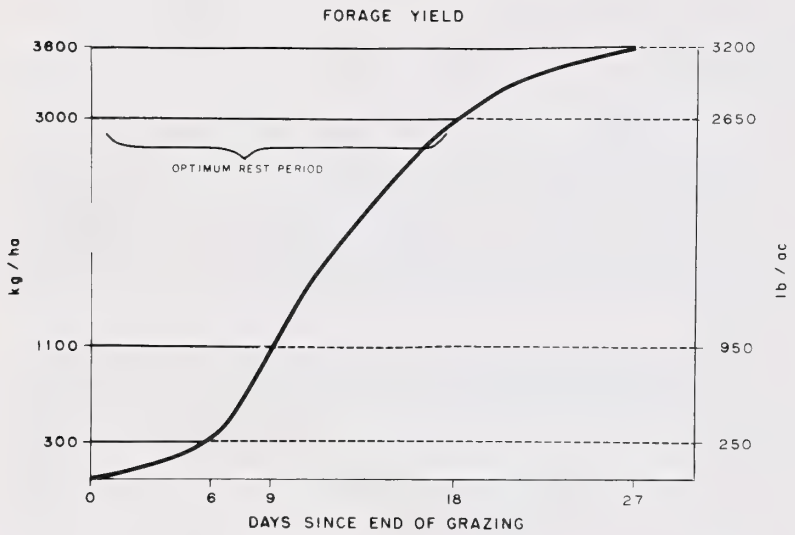

FIGURE 35.
Note the rapid surge of growth after a relatively slow start on irrigated pasture.

Under good growing conditions, it takes the plant six to eight days to attain sufficient growth for an animal to obtain a bite. If the plant is clipped as it starts its rapid surge of growth, it never gets a chance to replace the reserves it is using. As the reserves become depleted, the rate of growth decreases after each clipping and the total productivity declines.

To obtain maximum benefits from rotational grazing, there are three important rules to follow. These are:

- move livestock to the next pasture before the animal has the opportunity to graze the grass twice during the same occupation
- graze the pasture while the plants are in a leafy stage
- fertilize regularly and adequately. Forage stands containing less than 20 percent legume should be fertilized with adequate amounts of nitrogen.

Strip Grazing

This is an intensified system of rotation grazing, used mainly for dairy cattle. The pasture area is grazed in strips. This is accomplished by setting a movable electric fence across the pasture so as to allow the animals access to only enough grass to carry them for one day. Each day, the fence is moved forward to allow the stock access to a fresh supply of grass for the day. This system maximizes the period of regrowth of the pasture. In both rotational and strip grazing, there is an advantage to separating producing and non-producing cows in a dairy herd. Producers should be the first to graze, followed by the non-producers as 'clean-up animals'.

Strip grazing allows greater control of the factors affecting production, but there is an added cost of labor. This is discussed further under the heading "Choosing the System".

Zero Grazing

Under this system, the forage is harvested by machine and hauled to the livestock. The term is also used to describe the year-round feeding of cured hay or silage. In the latter case, however, the forage field is no longer treated as a pasture, but rather as a hay or silage crop and, therefore, is not discussed further here.

The daily cutting and feeding of fresh forage is more closely related to pasture consumption and, therefore, entails many management practices similar to those of ordinary pasture use. Management should, as in any pasture program, attempt to use the forage when it is in the early growth stage.

The advantage of zero grazing is that there is no loss from tramping and fouling. Consumption is complete as there is no opportunity for selective grazing.

The disadvantage of zero grazing is the higher cost involved. These include more labor, a need for a well drained feedlot, storing and hauling manure, substantial feed bunks, harvesting machinery, and, possibly, gravelled lanes to the forage fields. It also means being committed to the daily routine of harvesting forage for the animals. In some weather conditions harvesting may be difficult.

Zero grazing can give higher production than conventional grazing. But this does not necessarily mean a higher net return, because the additional cost may exceed the value of the increased production. This should be carefully considered before adopting zero grazing.

Complementary Grazing

This system makes use of seeded pastures in the spring and delays the grazing of native range until mid-June. Seeded pastures can also be used in the fall grazing period. Utilizing the proper pasture species at the right time can extend the grazing season to at least eight to nine months a year in many parts of the province (Fig. 36).

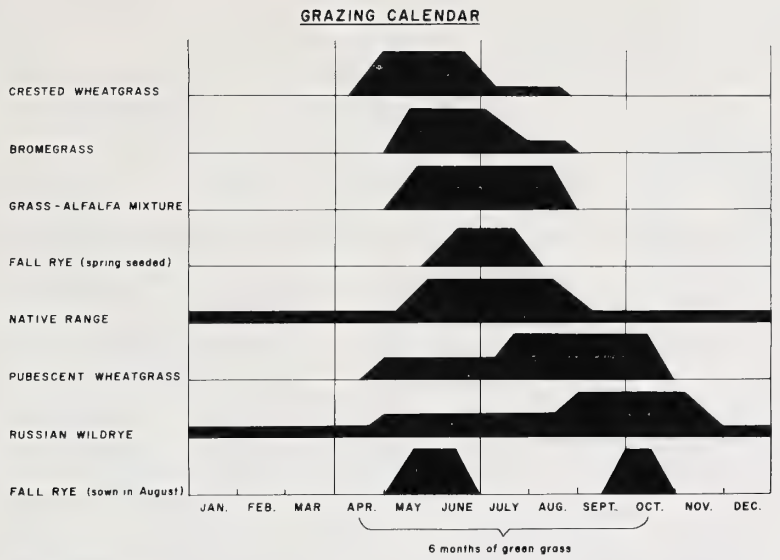

FIGURE 36.
Grazing calendar showing periods of high and low forage availability for some of the pasture crops grown in drier areas.

Grasses differ in their growth habits and seasonal palatability and should be used when they are most nutritious. Crested wheat grass and Russian wild-rye start growth very early in spring and are particularly useful for spring pasture. Brome grass and alfalfa growth is greatest in June and July. Pubescent and intermediate wheat grass remain palatable in late summer. Russian wild-rye has a long season of growth and a high nutrient content in the fall and, therefore, makes better fall pasture than other grasses. Annual crops, oats or fall rye, can be grown while a perennial crop is becoming established or during drought years, to provide forage during the grazing season.

The seeded pasture should be fenced so that it may be grazed as a separate unit. This will ensure maximum utilization and provide complete protection for the native range. However, if there is sufficient carryover or regrowth on the spring grazed pasture, the cattle can still have access to it during the summer.

Choosing the System

Increased production can be realized by adopting a more intensive management system. However, as management is intensified, the costs also increase. It is important to realize a dollar return from management. Therefore, the operator must consider the additional costs of labor, fencing, fertilizer, and machinery, and balance these against profits. Potential increase in production will vary from farm to farm and from one area of the province to another as a result of many factors, some of which are discussed here.

Amount of Moisture

In the drier areas, lack of moisture is the limiting factor to production. Some increase in production can be realized by intensifying the system but it will not be as great as where moisture is plentiful. Yet the added costs will be about the same. For this reason, it may not pay to go beyond continuous grazing in the drier areas. In contrast, on irrigated land, maximum forage use can be realized through a more intensive grazing system.

Land Values

High land value imposes a higher capital cost. To cover these additional costs, the operator must increase production. One way to do this is to increase the management input so that more units of production per unit area can be realized. Thus, the cost for land, which is a fixed cost, can be spread over a greater volume of production resulting in a lower unit cost.

Type of Livestock Enterprise

This has a marked influence on the gross returns the operator receives from his operation. Fluid milk production has a higher unit value than manufacturing milk. The value of production from a cow-calf beef operation is still lower. Therefore, the operator who is pasturing dairy cows for fluid milk production can intensify pasture management when others cannot justify the added costs.

Size of Operation

With a large livestock operation, the additional cost of the intensive pasture management is spread over a greater number of animals. Thus, the increase cost per animal is smaller in relation to the revenue received.

Nutritive Value of Forage Crops

The nutritive value of preserved forages varies greatly throughout Alberta and much improvement can be made towards improving quality. Quantity and quality are the two most important considerations regarding the timing of forage harvesting. By following good cultural practices, rapid growth and high yield of forage crops can be achieved. The first objective in forage harvesting is to produce the maximum amount of feed per hectare to meet the nutritional requirements of the livestock to be fed. A second, and often more practical consideration, is to harvest the maximum amount of high quality produce from the forage enterprise. The final decision on when to cut is a compromise between obtaining the highest quality and the greatest quantity.

The two most significant factors affecting hay quality at the time of cutting are the percentage of legume in the stand and the stage of development of the forage. Legumes are considerably higher in quality, especially crude protein, than grasses. Legumes also maintain a higher level of quality late into the season than grasses do.

The nutrient quality of forage crops decreases as maturity advances. As quality decreases the daily consumption by livestock also decreases, further reducing the animals' nutrient intake. This is most important with production rations for lactating cows, growing calves and finishing cattle.

Species, growing conditions, and stage of maturity all affect nutritive value of forages. Long-term average values showing the effect of stage of maturity on quality and intake are shown in Table 3.

Table 3 Feeding Value of Forages as Influenced By Stage of Growth at Harvest*

	TDN, %	Crude Protein % Grass	Crude Protein % Legume	Intake % of bodyweight
Vegetative	63	15	21	3.0
Boot or bud	57	11	16	2.5
Bloom	50	7	11	2.0
Mature	44	4	7	1.5

* Fisher, L.J. 1980. Agassiz Agriculture Canada Research Station.

As Figure 37 shows, grasses should be harvested at, or shortly after heading, and legumes from budding to about 10% bloom to obtain a maximum yield of total digestible nutrients per hectare. Early harvesting also has the advantage that more time is allowed for regrowth for additional harvesting or grazing.

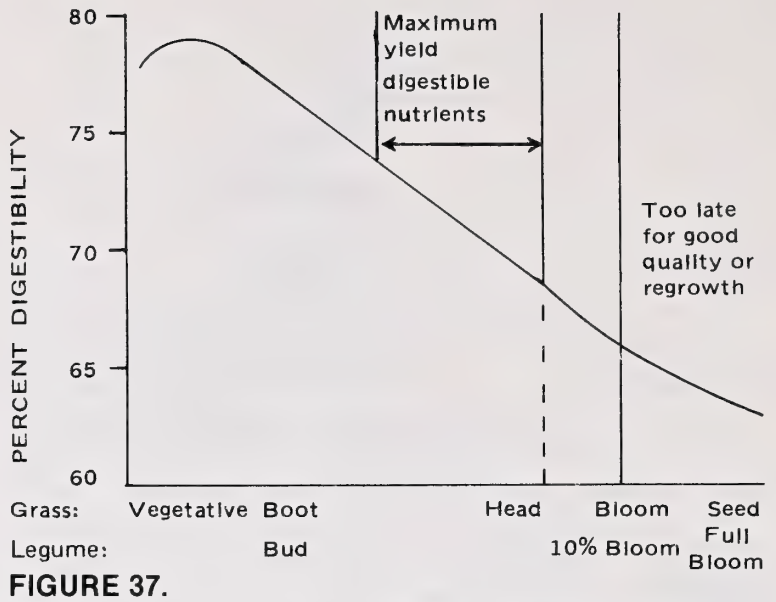

FIGURE 37.
Effect of maturity on digestibility of timothy, brome grass, orchard grass and alfalfa. Nappan Experimental Farm Results 1964-65.

While the highest hay quality is desirable for production rations, such as for milk production and body growth, lower quality roughage is useful for maintenance rations. However, when the feed is of higher quality than required, it can be mixed with lower quality feed such as straw, which is usually available. By utilizing lower quality feeds through mixing of feeds (e.g., mixing straw and hay), the forage hectares return a higher total value since nutrients are used in balanced proportions. Therefore, it is normally advantageous to harvest a maximum amount of protein and digestible nutrients by earlier cutting of forages.

Mechanical Processing of Forage

Several methods for the mechanical processing of feed can be used to increase daily consumption of forage and thereby increase production and feeding efficiency. They include grinding, pelleting, and cubing. Processed forage passes through the digestive system of ruminant animals more quickly than unprocessed forage. A larger surface area is exposed to the digestive process and, since processed forage has a higher density, the capacity of the rumen is increased.

Mechanical processing is most beneficial when using poor quality roughage, but it also improves the efficiency of utilization of good quality roughage (see Table 4). Mechanical processing makes more feasible the use of higher roughage rations for finishing cattle and milk production. However, processing is advantageous only in situations where daily intake of feed is a factor affecting performance, so that the costs and returns anticipated should be carefully assessed before making a decision.

Table 4 How Quality and Mechanical Processing of Alfalfa Affect Daily Gain and Intake of Winter Steers

Roughage fed	Good quality alfalfa (14.0% C.P.)						Poor quality alfalfa (11.9% C.P.)					
Physical form	Long	Chopped	Hammered				Long	Chopped	Hammered			
Hammermill screen size			50mm	25mm	12.5mm	5mm			50mm	25mm	12.5mm	5mm
Av. initial weight, kg	255	253	253	253	252	251	254	253	254	252	254	253
Av. daily gain, kg	0.50	0.52	0.68	0.71	0.71	0.79	0.29	0.35	0.45	0.51	0.62	0.56
Av. daily D.M. intake, kg	8.1	7.9	8.5	8.5	8.5	9.4	6.8	6.5	7.9	8.1	8.8	8.8
Kg D.M. per kg gain	16.2	15.1	12.5	11.9	11.8	12.0	23.7	21.5	17.5	16.0	14.2	15.6
Density kg/m³	176*	103	148	172	184	223	156*	83	122	119	178	186

* in the bale, prior to feeding
Melfort Agriculture Canada Research Station

Chopping roughage reduces wastage by the animals but may not have much effect on intake. On the other hand, very fine grinding is probably not necessary and may even reduce intake, gain and feed efficiency compared with that obtained with more coarsely ground roughage. For example, in the test mentioned above (Table 4), steers fed poor-quality alfalfa ground to pass through a 5 mm hammermill screen consumed the same amount of feed as those fed the alfalfa ground through a 12.5 mm screen, but gained an average of .05 kg/day less on the finer-ground feed. This may have been due to lower digestibility of the finer-ground roughage brought about by a faster rate of passage through the digestive tract. Factors such as dustiness may lead to a reduction in intake of finely ground roughages.

Forage Harvesting and Storage Losses

Nutritive losses following forage cutting may significantly affect the final quality of forage. Deterioration in the quality of feed occurs as a result of the effect of excessive sunshine exposure and overdrying, as well as from precipitation.

Dry Hay Harvesting Systems

Forage losses during cutting are normally low, but the choice of cutting equipment has a major effect on subsequent leaf loss. Self-propelled windrowers or mower conditioners are the most suitable harvesting machines presently available. The use of a hay conditioner results in more uniform drying of both stems and leaves; this decreases drying time and normally results in lower weathering losses. Mower conditioners should generally be set to form a windrow rather than a full width swath. This reduces time, expense and dry matter loss associated with raking.

There is a decrease in nutritive value from the time forage is cut until it is "put up". Several factors are involved.

Plant respiration continues to occur after cutting. This can result in the loss of up to 3% of dry matter per day with some respiration continuing as long as the moisture content of the forage remains above approximately 25%. Rain leaches out the most soluble nutrients and this loss is therefore greatest with the higher quality forages. Leaching losses can be as high as 15% of total dry matter. Also, the growth of molds and other micro-organisms is greater during wet weather, and these organisms utilize the most nutritious portions of the forage. Leaf losses are much larger for weathered forage since it is often raked twice.

Initial studies by the University of Alberta indicate the extent of losses that occur when rainfall delays the baling of hay. The losses result from leaching of soluble nutrients, respiration, leaf losses, and mold. Table 5 indicates the decrease in digestibility of the feed because of weathering. These losses are over and above the actual dry matter losses, and reflect the decreased value for maintenance rations only. The effect of weathering on production rations is much greater.

Table 5 Relative Value of Undamaged and Damaged Hay in Maintenance Diets

Description	Rainfall	% Decrease in Energy Content
Alfalfa hay	12.7mm (Sept. 30 - Oct. 20)	0.7
Timothy mixture	25mm (Aug. 15 - Aug. 31)	3.9
Alfalfa-timothy*	38.1mm (July 15 - Aug. 12)	17.9
Timothy	33.0mm (Aug. 15 - Sept. 14)	5.6
Brome-timothy-alfalfa*	38.1mm (July 16 - Aug. 13)	14.0
Mean		8.4

* Raked before baling
University of Alberta, Edmonton, 1980.

Excessive leaf losses occur when raking and picking up overdried hay. Leaves contain a very high proportion of the total digestible nutrients of hay. Alfalfa leaves contain two to three times more crude protein, but only one-third to one-fourth as much fibre as stems. In legumes, the leaves contain approximately 70% of the protein of the entire plant. Most of the dry matter loss which results from handling overdried hay is the consequence of leaf loss, so the actual loss in total digestible nutrients is larger than the actual weight loss indicates.

Raking losses of 5-10% of total dry matter for one raking are common and losses of up to 25% can occur. Even turning a windrow to speed the drying process can result in a dry matter loss of 10% or more. Raking when the moisture content is above 40%, and decreasing the number of rakings will reduce leaf loss.

Leaf losses with the various baling and pick-up systems commonly used are approximately the same. They are in the range of 3-5% of total dry matter under favorable conditions. Poor windrows, improperly adjusted pick-ups, slow ground speeds, or overly-dry hay frequently result in losses of 10-15% of total dry matter. Leaf losses can be kept down without affecting the preservation qualities of the final product by operating at as high a moisture content as possible. With baling systems this means operating at approximately 20-25% moisture, although larger, more compact bales need to be slightly drier than others. Large round balers operating at lower moisture contents (10-15%) give rise to much higher losses than small square balers. Another factor affecting losses with large round bales is the number of turns the bale makes while it is being formed inside the baler. Whenever possible, windrows should be made large enough to produce a bale in three to four minutes at normal operating speeds.

A large amount of forage is spoiled in Alberta as a result of leaving bales on fields or leaving them without protection from rain. Large well made stacks of compact bales will expose less surface and offer more resistance to moisture penetration. Large round bales should be stored individually or with flat sides touching as the piling and contact of rounded ends results in more spoilage. However, with all baling systems some form of protection from rainfall generally saves enough hay to justify its cost. The most reliable form of protection is a hay storage shed.

Harvesting losses with loose hay stackers are extremely variable. Losses tend to be somewhat higher than with baling systems, averaging 10 percent of total dry matter. An operator experienced at forming dense stacks with smooth and well-rounded tops can keep losses comparable to other dry forage harvesting systems.

Hay that is harvested too moist results in losses because of mold and heating. The precise moisture content at which deterioration begins depends on the size and density of the harvested "package", as well as on drying and storage conditions afterwards. Deterioration of quality may become a factor if hay is put up at more than 25% moisture. Mold can cause a loss of dry matter which is given off as heat. With dry haying systems, losses are mainly associated directly with the mold itself rather than with heating. However, if mold activity raises temperatures to 40 °C or more, a complex reaction known as the "browning reaction" occurs. Once started, this is a self-sustaining chemical reaction with results in a decrease in the digestibility of protein and carbohydrates in the forage. The National Academy of Sciences (1978) recommends that if feeds are moderately heat damaged, as determined by a brownish color, then the useful protein content is decreased to 80% of the original value. A dark brown or black color indicates less than 50% of the protein may be digestible.

Silage Harvesting & Storage

Overall nutritive losses with silage systems tend to be less than for other methods of harvesting forage. Since this harvesting system is less dependent on favorable weather, there is greater control of the quality of the final product. The main advantage of silage is the decrease in losses between cutting and storage. Total leaf losses with silage are very low compared to dry harvesting systems. Leaf losses with direct cut silage (moisture content above 70%), are 1-2% of total dry matter, while those for wilted silage (moisture content 50-70%) are about 5-7%. However, wilted silage results in improved fermentation and fewer storage and seepage losses, and is therefore the preferred method of making silage. Respiration losses in the field are about 3% of dry matter per day, but total drying time is only one-fourth to one-third of that required for dry hay systems so that total respiration losses are much lower.

Various tests in Canada and the U.S.A. indicate that, under favorable conditions, dry matter losses during storage of wilted silage are about 5-6% with oxygen limiting silos, 8-10% with upright concrete silos, and 10-15% with well made horizontal silos. To keep losses down careful attention must be given to various aspects of silage making.

A moisture content above 70% will result in poor fermentation and excessive seepage. With moisture below 50%, heat damage is a likely problem, although oxygen-limiting silos permit the ensiling of somewhat drier material.

The temperature of silage should not rise over 40 °C. At higher temperatures, the browning reaction results in a decrease in the digestibility of protein and carbohydrates in the forage. This can result in very high losses with silage.

Forage should be cut into short pieces to assure adequate packing of the silage. Setting the harvester to cut at a length of 6-8 mm results in an average actual length of 12 mm. This is small enough for all but very low moisture silage which requires still shorter lengths to permit adequate packing. Silage must be packed well to prevent air penetration. With horizontal silos continuous packing during filling is desirable. If filling is stopped for more than a day the silo should be covered. Silos should be sealed with a plastic cover which is weighted down to prevent excessive surface spoilage when filling is completed.

Summary

Every forage harvesting system has its advantages and its disadvantages. While some systems are more vulnerable to losses than others, all methods can be made more efficient by understanding basic weaknesses and taking advantage of strengths. The final choice in systems also depends on specific circumstances and on economic factors. The Alberta Feed Testing Laboratory indicates that, for example, the average crude protein content of 2,600 alfalfa-grass hay samples during the period 1965-1975 was 13.1%. The range in crude protein content was 3.7% to 24.9%. While careful harvesting management minimizes the variation in quality, it is best to have forage quality tested to assure that balanced rations are fed.

Soil Fertility and Fertilization

An adequate supply of plant nutrients is necessary to promote maximum growth of forage crops. Fertilization of forages should account for differences in nutrient requirements of legumes and grasses, differences in the nutrient supplying power of soils, and climate. Chemical analyses of the soil are a guide to the nutrient status of soils and will identify soil characteristics, such as salinity and acidity, that affect crop adaptation. It is important to select forage species that are adapted to both the soil and climate of the area.

In the drier areas of the province, responses of forage crops to fertilizer will be quite variable because of moisture conditions. However, residual responses 1-3 years after the year of application commonly occur, particularly after higher rates of application. Therefore, returns from forage fertilization should be assessed on more than a one-year basis.

Nutrient Requirements of Legumes and Grass

Legumes

When properly inoculated, legumes can use nitrogen from the air and therefore need little or no additional nitrogen from fertilizer. However, legumes require relatively large amounts of phosphorus, potassium, and sulphur, and will respond to the addition of these nutrients as fertilizer when they are not adequately supplied by the soils. Legumes generally respond to phosphatic fertilizers when soil analysis shows this element in the low and medium range, and to potassium and sulphur when these elements are deficient. Most Alberta soils contain adequate levels of potassium, but many Gray Luvisol and some Black soils are deficient in sulphur for legume crops.

Grasses

Grasses require relatively large amounts of nitrogen fertilizer and smaller amounts of phosphorus, potassium, and sulphur. Where moisture conditions are favorable, grasses will respond to high rates of nitrogen fertilizer and to moderate rates of phosphorus, potassium, and sulphur on soils deficient in these elements.

Grass–Legume Mixtures

When mixtures are grown, it is not possible to apply fertilizer to supply an ideal combination of elements for both the grasses and legumes. For example, if nitrogen is applied to a brome grass-alfalfa crop, the brome grass will tend to increase at the expense of the alfalfa. The alfalfa will also use some of the nitrogen fertilizer, and obtain less nitrogen from the air. In effect, some of the nitrogen applied is wasted because it is used in place of nitrogen that would have been fixed by the alfalfa. However, grasses growing with legumes do not obtain nitrogen directly from the legume and usually produce higher yields when fertilized with both nitrogen and phosphorus than with phosphorus alone. In many cases, better results have been obtained from applying nitrogen-phosphate fertilizers (for example, 23-23-0) at relatively high rates every 2-3 years than from the same amount applied in annual applications. One relatively large application of nitrogen to a grass-legume crop apparently has less effect on reducing the amount of legume in the stand than the same amount in annual applications.

Acidic Soils

About 20% of the cultivated soils in Alberta are acidic (pH of 6.0 or less). When soil pH is less than 6.0, yields of acid-sensitive crops such as alfalfa and sweet-clover are reduced. If soil pH is less than 6.0, lime should be applied if alfalfa or sweet-clover is to be grown.

Guide to Fertilizer Use on Hay and Pasture Crops

The following is a general guide to fertilizer use on various forage crops and soil types. The recommendations in the table give a wide range of application rates because fertilizer response can vary widely because of differences in nutrient status of soils and because individual producers will want different levels of production. It is recommended that soil tests be used to determine deficiencies of nitrogen, phosphorus, potassium, and sulphur and to identify other soil characteristics, such as acidity and salinity, that affect forage yields and fertilizer response.

This table shows the approximate amounts in kg/ha of nitrogen (N), phosphate (P_2O_5), and sulphur (S) required by various crops for the four areas in Alberta. Potash (K_2O) is recommended only when soil chemical analyses indicate a deficiency.

Area	Element	Grasses +	Mixtures 20-40% legume	Mixtures 40-60% legume	Legumes ‡
Area 1		*	*	*	*
Irrigation	N	56-112 ±	45-78 ±	34-56	0-11
	P_2O_5	0	56	56	34-67
Area 2	N	45-90	34-67	11-45	0-11
	P_2O_5	0-17	0-22	0-34	0-34
Areas 3 & 4	N	56-112	45-90	11-45	0-11
	P_2O_5	0-34	0-34	0-45	0-56
	S	0-11	0-22	0-22	0-22

\+ Grasses or mixtures with less than 20% legume.

‡ Legumes or mixtures with more than 60% legume.

* In Area 1, fertilizers are not generally recommended on dryland.

± To maintain peak production, follow with another 56 kg N/ha in mid-June and again in mid-July.

Area 1 (Brown Soils)

The use of fertilizer is not generally recommended on dryland hay and pasture crops in this area. Fertilizer response is greatly affected by summer rainfall and by the soil's ability to store moisture.

Irrigation (In Areas 1 and 2)

The use of fertilizer on irrigated hay and pasture crops

is profitable as yield increases are dependent on soil fertility and not rainfall.

Area 2 (Dark Brown and Thin Black Soils)

Fertilizer response is affected by summer precipitation. Fertilizers should be tried on small areas of hay and pasture crops before embarking on a large fertilizer program. Annual applications of fertilizer on dryland hay and pasture crops may not be necessary; residual response may continue for two to three years depending on rainfall after application. An unfertilized strip should be left as an indicator for future fertilizer applications.

Areas 3 and 4 (Black and Gray Luvisol Soils)

Fertilizer response in this area is generally good since more moisture is available than in Areas 1 and 2. This group includes the Peace River Region.

Fertilizer Application

Broadcast application is the only practical method of applying fertilizer to established forage stands. It is best to fertilize forages in late fall or early spring to provide an opportunity for precipitation to move the fertilizer into the root zone before the growing season.

Nitrogen fertilizers are soluble and move readily in moist soils. Response to nitrogen application is usually rapid if moisture conditions are favorable. However, nitrogen fertilizers, particularly urea (46-0-0), may be lost by volatilization (loss of vapor) if they remain on the soil surface during warm dry weather. Volatilization losses occur more readily on soils containing free carbonates (free lime). On irrigated land, mid-season applications should be watered in.

Phosphorus does not move readily in soils. Therefore, response to surface-applied phosphate fertilizers will not be as rapid nor usually as dramatic as to nitrogen application. Residual responses are common for 2-3 years after application. On soils very deficient in phosphorus, it is recommended that a relatively high rate of phosphate be applied and worked in before legumes of grass-legume mixtures are seeded.

FIGURE 38. Alfalfa

FIGURE 39. Sweet-clover

FIGURE 40. Alsike clover

FIGURE 41. Red clover

FIGURE 42. White clover

FIGURE 43. Bird's-foot trefoil

FIGURE 44. Sainfoin

FIGURE 45. Cicer milk-vetch

FIGURE 46. Altai wild-rye

FIGURE 47. Russian wild-rye

FIGURE 48. Crested wheat grass

FIGURE 49. Intermediate wheat grass

FIGURE 50. Pubescent wheat grass

FIGURE 51. Slender wheat grass

FIGURE 52. Western wheat grass

FIGURE 53. Northern wheat grass

FIGURE 54. Tall wheat grass

FIGURE 55. Perennial rye grass

FIGURE 56. Smooth brome grass

FIGURE 57. Meadow brome grass

FIGURE 58. Meadow brome grass seeds are larger than smooth brome grass seeds

FIGURE 59. Kentucky blue grass

FIGURE 60. Creeping red fescue

FIGURE 61. Meadow fescue

FIGURE 62. Tall fescue

FIGURE 63. Meadow foxtail

FIGURE 64. Timothy

FIGURE 65. Reed canary grass

FIGURE 66. Depth control bands for seeding

FIGURE 67. Grazing pasture in vegetative stage

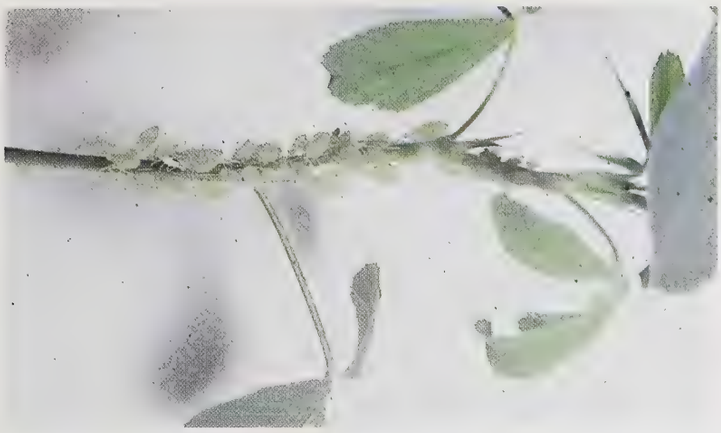

FIGURE 68. Pea aphids on alfalfa

FIGURE 69. Adult pea aphid

FIGURE 70. Alfalfa weevil larva

FIGURE 71. Alfalfa weevil

FIGURE 72. Alfalfa curculio

FIGURE 73. Clover leaf weevil

FIGURE 74. Sweetclover weevil

FIGURE 75. Sweetclover weevil damage

FIGURE 76. Lygus nymph

FIGURE 77. Lygus bug

FIGURE 78. Superb plant bug

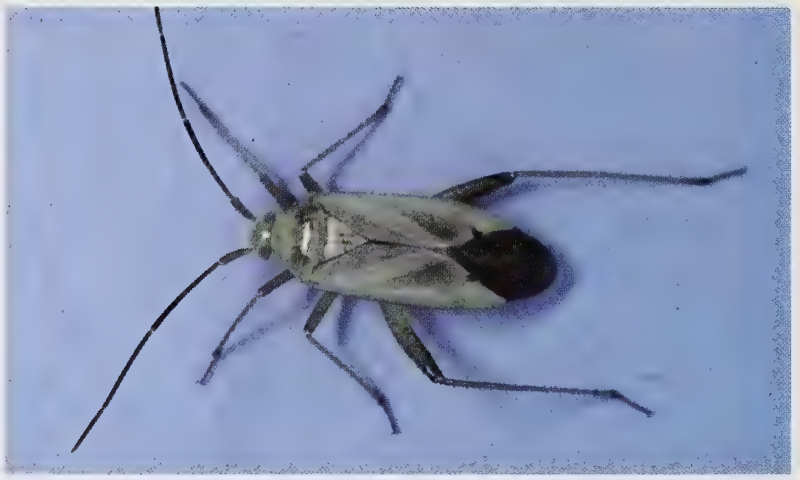

FIGURE 79. Alfalfa plant bug

FIGURE 80. Alfalfa looper

FIGURE 81. Alfalfa looper moth

FIGURE 82. Alfalfa caterpillar

FIGURE 83. Alfalfa caterpillar butterfly (male left; female right)

FIGURE 84. Clover cutworm

FIGURE 85. Clover cutworm moth

FIGURE 86. Redbacked cutworm

FIGURE 87. Redbacked cutworm moth

FIGURE 88. Pale western cutworm eggs

FIGURE 89. Pale western cutworm

FIGURE 90. Pale western cutworm pupa

FIGURE 91. Pale western cutworm moth

FIGURE 92. Twostriped grasshopper

FIGURE 93. Clearwinged grasshopper

FIGURE 94. Migratory grasshopper

FIGURE 95. Grasshopper egg pod and eggs

FIGURE 96. Pea aphid and thrip

FIGURE 97. Webbing and twospotted mites on alfalfa

FIGURE 98. Minute pirate bug killing mite

FIGURE 99. Thrip damage to alfalfa (left)
Mite damage to alfalfa (right)

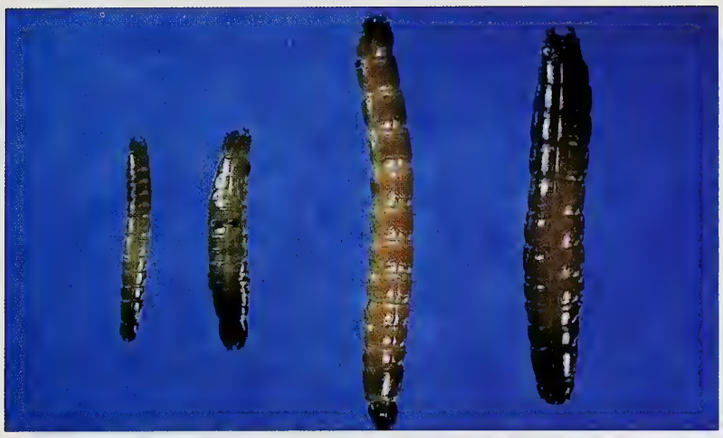

FIGURE 100. Four species of wireworms

FIGURE 101. Three common click beetles (adults of wireworms)

FIGURE 102. Mountain leafhopper

FIGURE 103. Blister beetle on alfalfa

FIGURE 104. White grub (Credit: Dr. R. Howard, Brooks, Alberta)

FIGURE 105. June beetle, *Phyllophaga anxia* Leconte (adult of white grub)

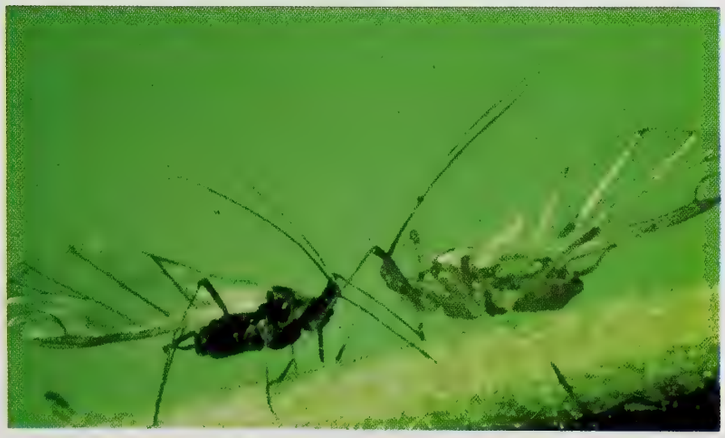

FIGURE 106. Winged blue alfalfa aphid (left) Winged pea aphid (right) (Credit: Dr. N.W. Nielson, Tucson, Arizona)

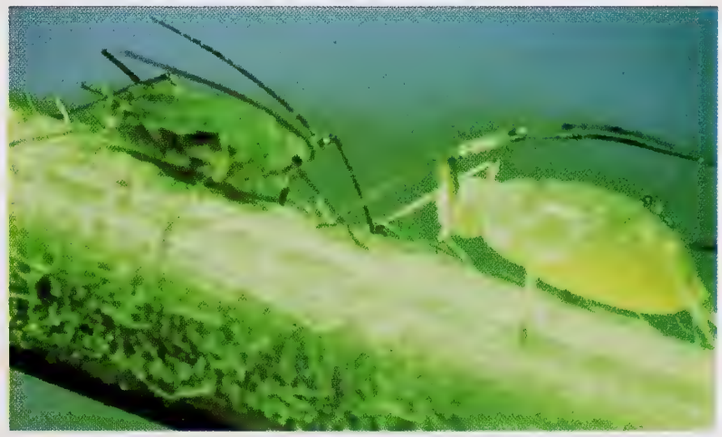

FIGURE 107. Wingless blue alfalfa aphid (left) Wingless pea aphid (right) (Credit: Dr. N.W. Nielson, Tucson, Arizona)

FIGURE 108. Ladybird beetle larva devouring pea aphid

FIGURE 109. Ladybird beetle eating pea aphid

FIGURE 110. Larvae of goldeneye lacewing feeding on pea aphid

FIGURE 111. Goldeneye lacewing feeding on pea aphid

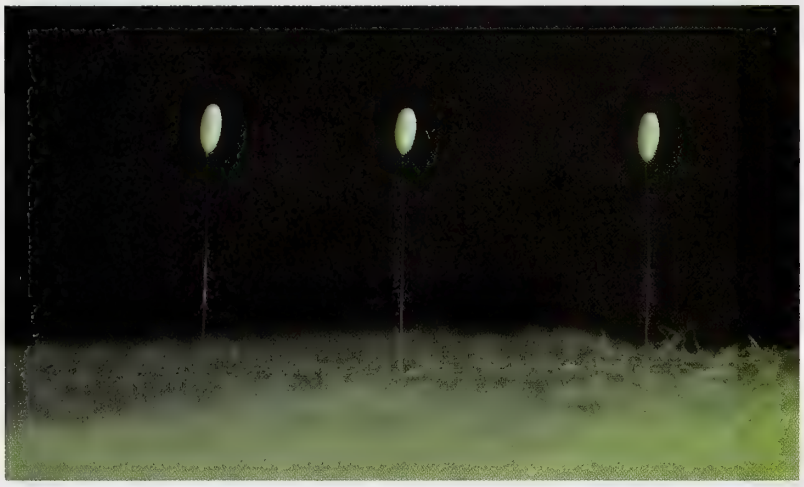

FIGURE 112. Eggs of goldeneye lacewing

FIGURE 113. Larvae of the hover fly, *Scaeva pyrastri* (L.) feeding on a pea aphid

FIGURE 114. Larva of the hover fly, *Eupoedes volucris* O.S. feeding on a pea aphid

FIGURE 115. Adult hover fly

FIGURE 116. Bigeyed bug

FIGURE 117. Western damsel bug

FIGURE 118. Minute pirate bug nymph feeding on pea aphid

FIGURE 119. Minute pirate bug piercing and feeding on pea aphid

FIGURE 120. Predatory thrip, *Aelothrips fasciatus* (L.)

FIGURE 121. Pea aphids parasitized by *Aphidius* parasites

FIGURE 122. Pea aphid mummy and emerged *Aphidius* parasite

FIGURE 123. Pea aphid killed by fungus *Entomophthora* sp.

FIGURE 124. Lacewing larva eating small lacewing larva

FIGURE 125. Lacewing larva eating adult lacewing

FIGURE 126. Ladybird beetle larva eating ladybird beetle eggs

FIGURE 127. Ladybird beetle larva eating small ladybird beetle larva

FIGURE 128. Ladybird beetle larvae eating lacewing larva

FIGURE 129. Honey bee

FIGURE 130. Alfalfa leafcutting bee pollinating flower

FIGURE 131. Bumble bee

FIGURE 132. Common leaf spot on alfalfa

FIGURE 133. Yellow leaf blotch on alfalfa

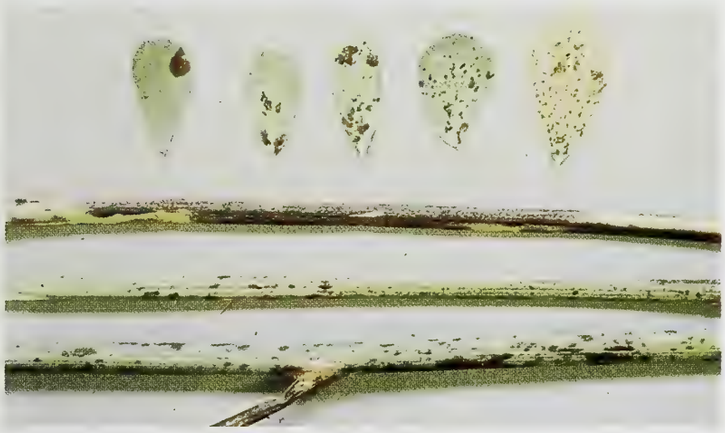

FIGURE 134. Black stem of alfalfa

FIGURE 135. Downy mildew of alfalfa

FIGURE 136. Verticillium wilt of alfalfa

FIGURE 137. Winter crown rot or snow mold of alfalfa (on roots)

FIGURE 138. Winter crown rot or snow mold of alfalfa

FIGURE 139. Crown bud rot of alfalfa

FIGURE 140. Northern anthracnose of red clover

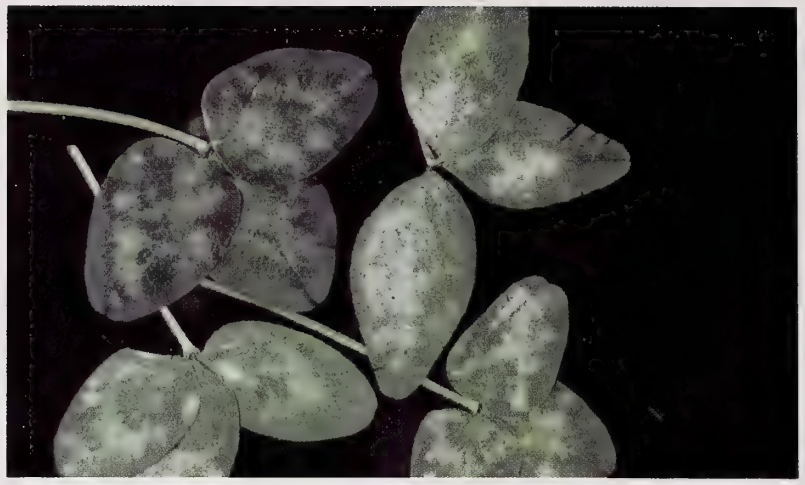

FIGURE 141. Powdery mildew of red clover

FIGURE 142. Sooty blotch of alsike clover

FIGURE 143. Snow mold on creeping red fescue

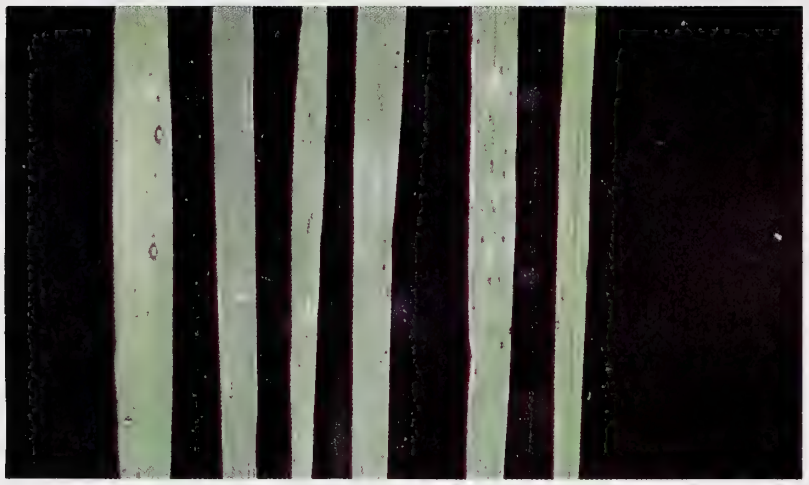

FIGURE 144. Purple spot on timothy

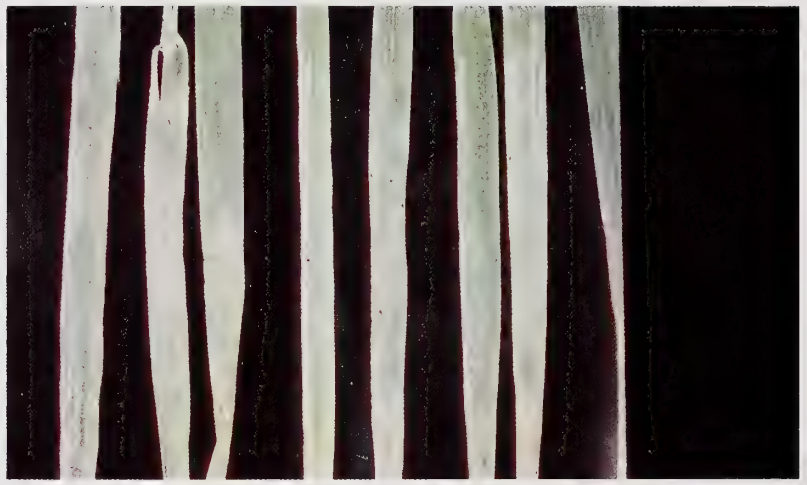

FIGURE 145. Leaf streak on tame hay

FIGURE 146. Brown leaf spot of brome grass

FIGURE 147. Bacterial wilt of alfalfa

FIGURE 148. Alfalfa stem nematode

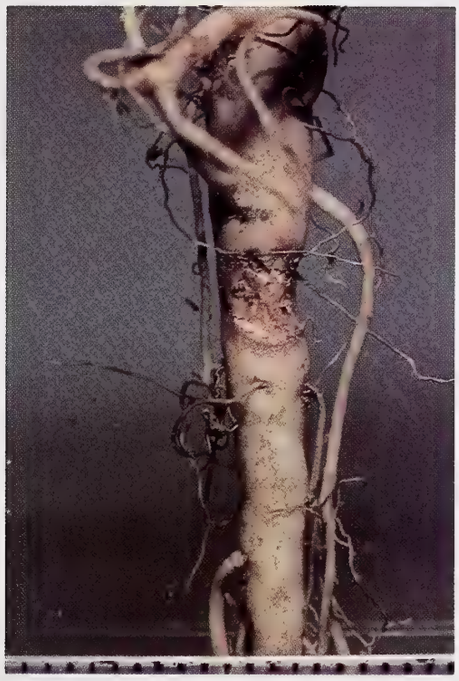

FIGURE 149. Brown root rot of sweet-clover

FIGURE 150. Selenophoma leaf spot on brome grass

FIGURE 151. Stem eyespot on red fescue

FORAGE INSECTS

In North America, nearly 1000 species of arthropods have been found to be associated with alfalfa and many other species have been found on other forages. Most of these species do not directly influence forage production. Some are plant feeders, some are pollinators, some are predators or parasites, many are transients, and many feed on other plants or on decaying organic matter in forage fields.

Large areas of forage are grown in Alberta for pasture, hay, silage, cubing, and dehydration. These forage crops are essential for our large cattle industry, for our forage export business, and for our grass and legume seed industry. As the production of forages can be seriously limited by insect pests, this section has been prepared to better acquaint agriculturists with the more important pests and beneficial insects of these crops.

In this section, chemicals for control of the pests are not listed as they change from one year to the next. Each year, Alberta Agriculture publishes a list of the latest chemical control recommendations for insect pests of Alberta. Satisfactory control depends on proper timing of treatment, thorough application of a recommended insecticide, accurate dosage, and use of effective equipment.

All directions and precautions listed on the insecticide label should be followed carefully. A time interval is required between the last application and harvest. The interval varies with the crop, the material used, the number of applications, and the amount applied.

Killing of honeybees and other pollinators must be minimized. When it is necessary to treat a crop in bloom, use insecticides that create the least risk to bees and avoid spraying the bees by applying the insecticide in the evening after the bees have left the field or before they return in the morning, usually after 7 p.m. or before 7 a.m. Insecticide drift into bee yards and into adjacent crops in bloom should also be avoided. Beekeepers should be notified at least 48 hours before spraying so they can take measures to protect the bees.

Pests

Pea Aphid (Figures 68 and 69)

Alfalfa in Alberta may be severely damaged by the pea aphid, *Acyrthosiphon pisum* (Harris). This insect, which also feeds on sweet-clover, trefoil, vetch, sweet peas, and several varieties of clover, is found in Alberta wherever peas and forage legumes are grown. High populations and damage usually occur before the second cut in late July or early August but also, rarely, may occur before the first cut in late May or early June.

Damage — The aphids mainly infest the growing tips of plants. Both the adults and the young suck juice from leaves, petioles, stems, and flower buds. Infested pea plants become stunted and their yield and quality are reduced. Injury to alfalfa is distinctive and a heavily infested area in a field may be apparent from a considerable distance. The plants are stunted and wilted, the top leaves are light green and the lower ones yellow or dead. From a distance, the affected area appears brownish. The bare ground is readily seen and is usually covered with whitish molted skins of the aphids. Where alfalfa growth is retarded, weeds often take over and crowd out the alfalfa. High populations of aphids can also reduce cold hardiness of alfalfa.

Description and Life History — The adult pea aphid is soft bodied, slim legged, slow moving, and ranges in color from light to dark green. It is about 3 mm long and 1.5 mm wide. The nymph is smaller but otherwise resembles the adult.

The pea aphid overwinters as an egg on leaves and stems of alfalfa and clover. In spring, when the plant resumes growth, a small, light green, wingless female hatches from each egg. These aphids, which are all females, can reproduce without mating. They feed on the growing plants and give birth to other female young. Some aphids of the second and third generations become winged and migrate to peas and other acceptable host plants. Here they feed and produce wingless females that, in turn, give rise to other generations of both winged and wingless females.

The aphids develop from birth to maturity in 5-50 days depending on the weather. All pea aphids are female throughout spring and summer and a summer-form female can produce from 50-150 young during her life. Whenever an alfalfa crop is cut during spring or summer, the winged aphids leave to search for new plants on which to live.

In late September or October, winged males and wingless egg-laying females are produced. These mate and the female lays eggs. The eggs, which are deposited on alfalfa leaves and stems, are yellow when first laid but soon turn green and then shiny black. Pea aphid eggs are able to survive low temperatures that kill other forms of the aphid.

Control — Predators and parasites attack the pea aphid and help to keep it under control. Usually they become abundant only when the aphid is abundant. The predators are mainly damsel and pirate bugs, adults and larvae of ladybird beetles and lacewings, and larvae of hover flies. The parasites are the larvae of tiny wasp-like insects that live in the aphids and kill them. When the aphids are unusually abundant, spiders and birds also destroy them.

A fungus disease may sometimes eliminate infestations of aphids in warm, moist weather.

Several pea varieties are not severely damaged by aphids. Some aphid-resistant varieties of alfalfa that have

been produced in the U.S.A. will survive the winter in Alberta.

Weather that is favorable for rapid growth of alfalfa greatly reduces the possibility of aphid damage. Aphid infestations may be reduced by very hot weather and retarded by cold weather. Heavy rains may dislodge and kill aphids.

Insecticides used for aphid control should be applied before the plants are severely damaged. Farmers should, therefore, keep careful check on the build-up of aphid populations in their fields. One properly timed application of insecticide per season usually gives satisfactory control.

Alfalfa Weevil (Figures 70 and 71)

The alfalfa weevil, *Hypera postica* (Gyllenhal), was first found in Alberta in 1954 in the valley of the Milk River. The weevil appeared to migrate into Alberta from Montana where it had become established in 1930. The alfalfa weevil is one of the most important pests of alfalfa in the U.S.A. and Ontario.

Damage — Young alfalfa weevil larvae severely damage shoot tips by feeding within the folded leaves but the damage is not readily seen at first. Older larvae feed on the open leaves. Defoliation is most severe toward the terminals, giving the entire field a greyish appearance. High populations of larvae may severely defoliate plants leaving only leaf fragments and stems.

The adults scar shoots by feeding and cause further damage by egg laying. Notched leaves are characteristic of damage by weevil adults.

When the insect was first recorded in Montana, damage occurred only in the first cutting alfalfa, but in areas where the weevil has been established the longest, damage also occurs to second cutting alfalfa. In 1977, the first reports of damage to alfalfa in August occurred in the area near Warner. One of the earliest records of weevils in Alberta was just south of this area.

The alfalfa weevil can reduce hay yield by 50%. Not only is the yield cut down but the quality of hay is greatly reduced. The feeding may also greatly reduce the potential yield of seed fields.

Description and Life History — The adult weevil is a snout beetle, about 5 mm long. The young adult is light brown with a darker brown stripe extending from the head to about three-quarters of the way down the back. Much of the light color of the young adult is due to colored scales. As the beetle gets older, these scales are gradually rubbed off, and it becomes dark brown to nearly black.

Adults normally overwinter in trash in protected places. The adults are quite mobile and may be found some distance from the nearest alfalfa. After the alfalfa has started to grow, the weevils feed for a few days, then they begin to lay eggs. An adult female lays about 600-800 eggs in clusters of 20 during her lifetime.

The weevil eggs are inserted into alfalfa stems. The adult female chews a hole in the stem before inserting the tip of her abdomen into the hole to lay a cluster of eggs. The newly laid eggs are light yellow or sometimes almost white.

The eggs hatch in 4-21 days, depending on the temperature. The larvae molt three times for a total of four larval instars. Larval development usually requires 3-4 weeks. The peak of larval activity usually occurs from mid-June to mid-July although some larvae are present throughout the summer.

The weevil larvae are about 1 mm long when they hatch. At first, they are light yellow with black heads. As the larvae grow, their bodies become bright green with a conspicuous white stripe down the middle of the back and their heads become dark brown. Full-grown larvae are 9 mm long.

About the time hay is generally cut, in late June or early July, the larvae start to pupate. The weevil pupae are formed within loosely woven lace-like white cocoons. The pupae are dark brown or nearly black and are found attached to the plant most frequently near ground level. The pupal stage generally lasts 1-2 weeks. Many larvae are killed by exposure during the cutting and harvesting process, but most pupae and adults survive.

New adults begin to appear in early July. From late June to the end of summer, young adults from the current year and old adults from the previous year can both be found in alfalfa fields.

Control — Early cutting of the first growth alfalfa while the weevil is still in the larval stage will reduce populations of new adults, but this is not always practical. Green chopping, instead of cutting, windrowing, and baling can result in seasonal reductions of about 50% in total numbers of weevils. Several experimental alfalfa varieties show some resistance or tolerance to the alfalfa weevil, but none show a high level of resistance.

A small wasp, *Bathyplectes curculionis* (Thomson), is important in biological control of the alfalfa weevil. In the past, this parasite was apparently one of the main factors keeping the weevil under control in Alberta. Other parasites are being introduced into the province for control of the alfalfa weevil.

Insecticides are available that give control of the weevil.

Sweetclover Weevil (Figure 74)

The sweetclover weevil, *Sitona cylindricollis* Fahraeus, is the chief pest of sweet-clover in Alberta. The adult weevils are difficult to see as they drop quickly from plants if disturbed and the larvae are not visible as they feed underground on the plant roots.

Damage — The weevils chew crescent-shaped, jagged notches in sweet-clover leaves. The weevil may defoliate the entire plant and even eat the outer tissue of the stem, or green seeds. Damage is most severe in dry years. New seedlings can be completely destroyed and second-year stands thinned and stunted. The weevils will feed on seedling alfalfa or cicer milk-vetch if no sweet-clover is available.

Description and Life History — Adult sweetclover weevils are small, dark grey, snout beetles about 4-5 mm long. They spend the winter under trash cover or in cracks in the soil in sweet-clover fields. They become active in spring and feed on sweet-clover. About mid-May, the beetles mate and the females lay eggs on the soil surface near host plants. The young larvae burrow into the soil and feed on sweet-clover roots where they complete their larval development. In late July, the mature larvae move upward and pupate just below the soil surface. The adults emerge about mid-August.

Control — Sow new stands of sweet-clover as far as possible from second-year stands. This reduces the risk of invasion by adults that are moving in spring or late summer. Sow high quality, scarified seed less than 2.5 cm deep in a firm, moist seedbed. This will assure even emergence of seedlings. When new seedlings emerge, watch for signs of weevil damage. If damage is becoming severe, apply a recommended insecticide.

Under favorable moisture conditions, second-year sweet-clover will outgrow damage caused by most infestations of sweet-clover weevil. As soon as possible after hay or silage has been cut and removed, second-year sweet-clover fields should be shallow-cultivated to destroy larvae and pupae below ground. New adults emerging in unworked hay fields migrate to new sweet-clover stands.

Alfalfa Curculio (Figure 72)

The alfalfa curculio, *Sitona scissifrons* Say, is a native weevil that initially fed on vetches but has been recorded damaging alfalfa, sainfoin and cicer milk-vetch. At present, it is not causing economic damage in Alberta but is considered to be a serious potential pest of sainfoin in Montana and could become important in Alberta.

Damage — The adults eat notches in the edges of the leaves of plants. The damage is usually not important on established stands but seedling fields of sainfoin, cicer milk-vetch or alfalfa may be destroyed. The soil-inhabiting larvae enter nitrogen-fixing nodules of the roots and eat out the contents. As larvae mature, they feed on additional nodules, root hairs, and roots of the plants.

Description and Life History — The alfalfa curculio adult is a light to medium-grey snout beetle similar to, but smaller than, the sweet-clover weevil. The adult overwinters in trash in fields and headlands and begins to feed on sainfoin or alfalfa leaves in early May. They feed throughout the summer on the leaves, especially the lower basal leaves. The adults mate during the spring and early summer and the females lay eggs around the base of the plant. The larvae are subterranean and pupate in the soil. The adults usually emerge during August but do not become sexually active until the next spring.

Control — Chemicals recommended for the sweet-clover weevil will probably control the alfalfa curculio.

Clover Leaf Weevil (Figure 73)

The clover leaf weevil, *Hypera punctata* (Fabricius), is present each year in forage legume fields but appears to cause only localized injury to alfalfa and several types of clover, as populations are low in Alberta.

Injury is restricted mainly to the foliage and appears to be very similar to that caused by the alfalfa weevil.

The clover leaf weevil is closely related to the alfalfa weevil and is similar in shape but is larger and does not have the dark-colored stripe down its back. The larvae are larger and less greenish than the alfalfa weevil larvae and are yellowish when full grown.

Chemicals recommended for the control of the alfalfa weevil will control the clover leaf weevil.

Lygus Plant Bugs (Figures 76 and 77)

Lygus bugs can cause problems in alfalfa hay but are more serious pests of alfalfa seed production. They feed on leaves, flowers, and developing seed of many plants. Several species of *Lygus* occur in Alberta with the most common being *L. borealis* (Kelton), L. *desertinus* Knight, and *L. elisus* Van Duzee. Both the nymphs and adults feed on alfalfa.

Damage — Lygus bugs have piercing-sucking mouthparts and physically damage the plants by puncturing the tissue and sucking the plant juices. The plants also react to the toxic saliva that the insect injects when it feeds. Lygus bug infestations (over 15 per sweep) can cause alfalfa to have short stem internodes, excessive branching, and small, distorted leaves. Hot dry weather favors build-up of lygus populations and increases the possibility of damage to early growth. Lygus bugs feed on buds and blossoms and cause them to drop. They also puncture seed pods and feed on the developing seeds causing them to turn brown and shrivel.

Description and Life History — The adult lygus are about 4-5 mm long and about 2-2.5 mm wide. They vary in color from pale green to reddish brown and have a distinct triangle about one-third of the distance down the back. The young nymphs are small, blue-green in color, and look like aphids but are more active. As the nymphs become larger, their color becomes more variable and covers about the same range as the adults, and they develop prominent black dots on the top of the thorax and abdomen.

Lygus bugs overwinter as adults under debris, litter, or plant cover along fencelines, ditchbanks, hedgerows, and wooded areas. The eggs are laid in alfalfa stems after the adults become active in spring. The eggs hatch between the end of May and mid-July when alfalfa is in bloom. The newly hatched nymphs moult five times during the next 20-30 days. There are two generations per year in southern Alberta but only one in the northern part of the province. Adults remain in the alfalfa until late summer when they move out of the fields to overwintering sites.

Lygus bugs are general feeders and are found on many herbaceous plants. The more important weed hosts in Alberta are flixweed, kochia, lamb's quarters, mustard, Russian knapweed, and Russian thistle.

Control — In most hay fields in Alberta, lygus do not need to be controlled. Most common predators that feed on aphids will also feed on lygus nymphs. Cutting the alfalfa for hay or for dehydration also reduces lygus populations. Chemical control may be necessary on alfalfa grown for seed production.

Use recommended insecticides when chemical control is necessary.

Adelphocorid Plant Bugs (Figures 78 and 79)

The superb plant bug, *Adelphocoris superbus* (Uhler), and the alfalfa plant bug, *A. lineolatus* (Goeze), are two of the plant bugs that can be a problem in alfalfa in south and central Alberta.

Damage — Both species belong to the same family as the lygus bugs and have similar habits to them. They feed on the buds, flowers, and seeds. The feeding causes buds to become blasted and die, flowers to drop, and seeds to shrivel and fail to germinate.

Description and Life History — The adults are about 8-9 mm long and about 2-2.5 mm wide. They are about the same width but twice as long as lygus. The superb plant bug is bright red with the mid-portions black. The nymphs are red with less black than the adults. The alfalfa plant bug is yellowish green to green, and the nymphs are mid to dark green.

The life histories of the two plant bugs are similar except that the alfalfa plant bug has two generations per year while the superb plant bug has only one. The eggs are laid in growing alfalfa stems and overwinter in the alfalfa stubble and straw left in the field after harvest. The eggs hatch from the end of May to mid-June. The nymphs moult five times before becoming adults. The life cycle from egg hatch to adult takes about 30 days.

Control — Thorough burning of the alfalfa stubble and debris in late fall or early spring before alfalfa starts to grow destroys the eggs of the plant bugs that were laid in alfalfa stems the previous summer and fall. Burning may control plant bugs in a field for more than one year. Burning does not control the lygus bugs because these insects and their eggs are not in the fields at that time. Cultural and management practices associated with haying ensiling, dehydrating, and cubing usually prevent the build-up of economic infestations of adelphocorid plant bugs.

If it is not possible to burn heavily infested alfalfa fields, the plant bugs can be controlled by the application of a recommended insecticide when the alfalfa is in the early bud stage.

Grass Plant Bugs

In Alberta, there are several plant bugs that damage forage grasses. These insects in the genera *Irbisia* and *Capsus* are black and are not the same plant bugs that damage alfalfa. The bugs in the genus *Irbisia* are about 7 mm long and 2 mm wide and those in the genus *Capsus* are slightly shorter and wider.

These plant bugs suck the juices out of the grasses and can kill them or cause them to produce white heads that contain no seed. When infested grass in ditches or in hay fields dries, these bugs frequently move into adjoining small grains and seriously damage them.

Although very little is known about these insects in western Canada, their life histories are probably similar to those of the plant bugs that commonly infest alfalfa as they all belong to the family Miridae.

The insecticides recommended for control of lygus or alfalfa plant bugs will also control these insects.

Alfalfa Looper (Figures 80 and 81)

The alfalfa looper, *Autographa californica* (Speyer), is found in alfalfa and other forage crops every year. Occasionally local outbreaks occur and damage can be severe.

Damage — Alfalfa loopers are general feeders and may damage forages, rape, garden vegetables, flowers, and fruit trees. Small larvae feed on leaf surfaces, medium-size larvae eat ragged holes through the leaves, and larger larvae feed along leaf margins and may defoliate a large portion of the plant or clip flowers and seed pods.

Description and Life History — The young larvae vary from light to dark green and are 1-2 mm long. The mature larvae are light to olive green with a pale green head and a light stripe down each side and two light stripes along the back. The larvae move with a looping motion, bringing the hind legs forward then releasing the front legs and extending the body forward. There are three pair of true legs on the forward portion of the body directly behind the head. Two pairs of prolegs are located toward the rear of the body and one pair on the last segment.

The larvae spin white, woolly cocoons in which to pupate. Pupae within the cocoon may be green to very dark brown. The adults are moths that have grey forewings with a distinct yellow sickle-shaped spot near the middle of each wing. The body and hind wings are dull grey or brown.

The alfalfa looper overwinters in the pupal stage in the soil or in plant debris near the base of the plant. The moths usually emerge in late April or early May. Because they generally fly at dusk and early night, the moths are seldom seen. As there are usually two to three generations per year, moths appear all summer because of overlapping generations. The pale ivory eggs are laid singly or in small groups on stems, leaves, or flowers of host plants. The eggs hatch in about one week and the larvae feed for about four weeks before becoming attached to a plant and spinning the cocoon in which they pupate.

Control — The alfalfa looper is usually held in check by its natural parasites and predators, and by diseases that often kill the larvae before they can pupate.

Where damage is becoming severe, apply a recommended insecticide.

Alfalfa Caterpillar (Figures 82 and 83)

The alfalfa caterpillar, *Colias eurytheme* (Boisduval), is found in Alberta but is usually only of minor importance because its populations are kept low by natural biological controls.

Description, Life History, and Damage — The larvae are velvety green with a white line extending along each side. They are about 30 mm long when fully grown. The pupae are green. The adult is a butterfly with a wingspread of about 45 mm. Most of the butterflies are yellow with black-

bordered wings but some white forms are found. The black border is a solid color in the males but broken by light areas in the females. The eggs, which are laid singly on the upper surface of leaves, are white when first laid but darken before hatching. There is usually more than one generation per year. Alfalfa caterpillars feed on the leaves and may defoliate parts of the plant.

Control — Alfalfa caterpillars are heavily parasitized by small wasp-like insects and are often attacked by disease. Normal crop harvesting often disrupts the life cycle and prevents the larvae from maturing.

If damage is becoming severe, apply a recommended insecticide.

Cutworms

Cutworms are sporadic pests of legumes and grasses as well as many other plants. Some cutworms are foliage feeders while others damage roots or cut off shoots. In Alberta, there are four common species: two that feed above ground, the army and clover cutworms; and two that feed mainly below ground, the pale western and red backed cutworms.

Above-Ground Feeders (Figures 84 and 85)

The army cutworm, *Euxoa auxilliaris* (Grote), is a surface feeder that assumes the 'army' habit of migrating in masses from one area to another. Migrations usually take place from uncultivated land to forage fields. Severe infestations are characterized by complete defoliation of plants. Army cutworms may also feed on cereals, mustard, and flax in Alberta.

The moths of the army cutworm have a wingspan of 35 mm. They lay eggs on soft soil. The larvae, which hatch from the eggs in a few days, remain in the soil during the day and feed at night on the leaves. The larvae are smooth, pale greenish grey to brown with a pale stripe on the back and white and brown fine splotches. They spend the winter as half-grown larvae that pupate in late May and June. The adults emerge in late June.

The clover cutworm, *Scotogramma trifolii* (Hufnagel), feeds above ground on foliage of forage crops, truck crops, sugar beets, rape, and weeds. There are normally two generations of clover cutworms per year.

The adults are uniform or mottled ash grey to pale brownish grey moths, with a wing span of 25-28 mm. The eggs, which are white to pale yellow, are laid on the underside of leaves. The newly hatched light green larvae feed on the undersides of leaves. The larvae pass through color phases of green to brown. Most mature larvae are green or pale brown with a wide yellowish pink stripe along each side. The larvae pupate in the soil. The species overwinters in the pupal form.

Below-Ground Feeders (Figures 86 – 91)

The pale western cutworm, *Agrotis orthogonia* Morrison, has only one generation per year. The larvae feed mainly on the roots of plants. Besides forages, the larvae attack cereals, mustard, flax, sugar beets, and certain weeds. Major damage is by older larvae eating into the stems and severing them just below the soil surface.

The adults, which emerge in August, are greenish-grey moths with distinct pale lines on the forewings and a wing span of 38 mm. The eggs are laid singly or a few together on or just below the surface of loose soil in August and early September. The species overwinters as eggs that hatch the following spring. Larvae are full grown by late June and are greenish to slate grey with a brown head. They vary in length from 30-36 mm. Full-grown cutworms form chambers or cells of soil particles in loose soil where they pupate. This species of cutworm does not migrate from field to field in search of food.

The red-backed cutworm, *Euxoa ochrogaster* (Guenee), has been recorded feeding on alfalfa, sweet-clover, alsike, sunflowers, cereals, sugar beets, flax, rape, mustard, vegetables, garden flowers, and seedling trees.

The young larvae eat holes or notches in the foliage. The presence of larger cutworms is indicated by dead, dried-up plants that have been severed just at or below the soil level.

The moths are light fawn to brick red. They lay small, globular eggs at night at or just below the surface of loose, dry soil in weedy stubble or fallow fields. The species overwinters as eggs that hatch in spring. The mature cutworm larvae have a reddish upper surface and are about 38 mm long. By mid-June, the larvae change in the soil into reddish brown pupae. The adults emerge in August and September.

Control — Cutworms are often kept under control by parasites, predators, and pathogenic organisms. Infestations can be reduced or prevented by cultural methods. If fields are cultivated early in spring and left bare of weeds and other growth for at least two weeks, young larvae of the pale western and red-backed cutworms may be starved.

Fields that have a protective crust throughout August and the first half of September are much less attractive for egg laying as the army, the pale western, and the red-backed cutworm prefer to lay their eggs in loose soil.

When damage is extensive, control can be obtained by spraying the soil and plants with a recommended insecticide.

Grasshoppers (Figures 92 – 95)

Several grasshopper species may damage pastures, hay fields, and grass and legume seed crops. The common ones are the migratory grasshopper, *Melanoplus sanguinipes* (Fabricius), the twostriped grasshopper, *Melanoplus bivittatus* Say, and the clearwinged grasshopper, *Camnula pellucida* Scudder.

Damage — The grasshoppers that damage legumes and grasses are the same species that damage field crops. They usually come from egg beds located in pasture and roadside sod, stubble fields, and banks of irrigation ditches. Injury occurs most frequently on small fields near uncultivated or abandoned land, or where fields are close to large range areas. Grasshoppers are voracious feeders and may devour leaves, buds, flowers, and seed pods.

Description and Life History — The adult migratory grasshopper is mottled greyish yellow to greyish brown. The hind femur has a pink stripe along the lower edge and the hind tibia is blue or pink. The species is 23-34 mm long. Twostriped grasshoppers are generally dark yellowish green with two yellow stripes extending from the head to the tip of the forewings. These grasshoppers are 26-40 mm long. Clearwinged grasshoppers are pale yellowish brown to black, with two converging pale stripes along the forewings, and are 21-32 mm long.

Most Alberta grasshoppers overwinter in the egg stage. The eggs are laid below the surface in a protective pod that may contain 20 or more eggs. Each female may produce a total of about 400 eggs during her reproductive period. The eggs hatch in late spring or early summer, depending on the weather. The newly hatched hoppers are wingless and only 4 mm long. They moult five times before they become adults. In late summer and early fall the females lay eggs that remain unhatched until the following spring. Females usually continue to feed and lay eggs until the first frost.

Control — Fall tillage of stubble land destroys many eggs and spring tillage that destroys green growth just as the grasshoppers hatch will starve many nymphs before they can find other food such as forages. Early each year, grasshopper forecast maps distributed by the provincial government show the expected extent and severity of grasshopper outbreaks for the following season.

Chemical control may be required in areas where outbreaks are forecast. Apply the recommended insecticide as soon as the grasshoppers threaten the crop. Barrier treatments applied between grasshopper breeding areas and forage fields are often effective. If high populations of grasshoppers are predicted, areas where young hoppers are hatching should be sprayed after eggs have hatched but before larger nymphs and adults have moved out.

Thrips (Figures 96 and 99)

Thrips occur on forages in very large numbers, especially on flowers. There are several species but the most common are the flower thrips, *Frankliniella tritici* Fitch, on alfalfa; the grass thrip, *Anaphothrips obscurus* (Mull.), on grasses; and the red clover thrip, *Haplothrips leucanthemi* (Schrank).

Damage — As these insects are extremely small, the damage they do to host plants is usually noticed before the insects are seen. Thrips feed on the plant cells and scarify the tissue surfaces. The damage appears as whitish blotches on the leaves, buds, and petioles. The flowers of crops grown for seed may be so damaged as to prevent seed production.

Stands that are being cropped for the first time have very few thrips in them. Usually the older the stand, the heavier is the infestation. Thrips seem to thrive best in warm, dry weather and infestations are usually heaviest in dry years.

Description and Life History — Adult thrips are less than 2 mm long, very slender, and have narrow wings fringed with long slender hairs. They are various colors. The nymphal thrips are similar in shape to the adults but smaller, lack wings, and are lighter in color.

Thrips overwinter as adults or mature nymphs in plant debris in fields and along headlands. Adults become active in spring and lay their eggs in slits that they cut in leaves or petals of suitable host plants. Eggs hatch in about 7 days and the nymphs feed actively for several days then drop to the ground and pupate. After emergence, the adults mate and either remain on the original host or fly to a new host to start another generation. There are several generations per year with each generation requiring three to four weeks to complete.

Control — Often thrips are kept under control on forages by predators such as anthocorid bugs, predatory thrips, and ladybird beetles. If damage by thrips is becoming severe, a recommended insecticide should be applied to the crop.

Mites (Figures 97 – 99)

Mites, mainly the two-spotted spider mite, *Tetranychus urticae* Koch, seldom appear as pests of hay alfalfa. They prefer mature or senescing foliage and may be a problem on seed crops. These mites are often a problem on forages in greenhouses as their predators are not present.

Damage — The mites concentrate on the underside of leaves where they feed and leave trails of webbing. The damaged areas become stippled with tiny translucent dots and eventually turn brown and dry, and the leaves drop from the plants. The mites gradually move up the plants where they destroy the leaves, and cluster at the top where they spin webbing over the flowers and leaves.

Description and Life History — Mites are barely visible to the naked eye. The two-spotted spider mite is less than 1 mm long, is eight legged, sparsely covered with hairs, and has a pair of dark areas near the sides of the body. The eggs are spherical, translucent, almost colorless, and are laid on the underside of leaves among the feeding mites. The mites are often blown to new areas on strands of webbing. The adults overwinter under debris in or near fields or in cracks in the soil.

Control — Mites are usually controlled in the field by predatory mites, predatory thrips, minute pirate bugs, and other insect predators. Where mites are a problem, they can be controlled by recommended miticides.

Leafhoppers (Figure 102)

Leafhoppers cause direct damage by their feeding but are even more important because they can transmit virus diseases affecting forage and other crops. Species found on forage in Alberta have been recorded as transmitting the following viruses in other areas: alfalfa dwarf, clover big vein, clover phyllody, clover proliferation, and clover yellows.

In Alberta, many species of leafhopper are present but none seem to be causing problems to forages either by direct feeding or by disease transmission. However, in some areas of the eastern and central U.S.A., leafhoppers are rated among the most serious pests of alfalfa.

Wireworms (Figures 100 and 101)

Several species of wireworm occasionally damage legumes and grasses in Alberta. These are the same species that damage cereals, and include species in the genera *Ctenicera, Hypolithus,* and *Agriotes.*

Damage — Wireworms feed on roots or germinating seeds of host plants, which causes thinning of the stand. Damage is likely to be more severe in legumes or grasses seeded into newly broken grassland.

Wireworms injure the plants by rasping and shredding the stems below the soil surface but do not cut off the stems as cutworms do. The injury causes the plant to wilt, turn yellow, and die. Sometimes the outer leaves of older plants remain green for some time after the central shoot has died.

Description and Life History — Wireworms are the larvae of click beetles. The beetles are black or brown and vary in size with some of the common ones about 13 mm long. Click beetles are easily identified because they spring into the air with a clicking sound when placed on their backs. No other beetle does this. The larvae are hard-bodied, slow moving, and vary from yellowish white to straw color. Fully developed larvae vary from 10-25 mm in length and each has a flattened, notched 'tail'. The pupae are solf, white, and delicate. The eggs are tiny and pearly white.

Wireworms take 1-10 years to develop from egg to adult. Each year, in July and early August, some larvae come to within 7-13 cm of the soil surface and pupate. In 3 weeks, the pupae change to beetles that remain in the soil overwinter. In May or June, they lay eggs that soon hatch. Each spring, wireworms move near the surface to feed, and as the top layer heats up and dries out they go deeper in the soil. In irrigated land, they usually feed much longer than in dryland.

Control — Where it is evident from previous crop damage or from spring sampling that a large wireworm population is present in a field, it is advisable to use a recommended insecticide, generally applied as a seed treatment the following season.

Blister Beetles (Figure 103)

Several species of blister beetle exist in Alberta. They are not usually important as pests but are considered to be beneficial as the larvae may destroy grasshopper and cricket eggs. At various times, especially during grasshopper outbreaks adult blister beetles may damage forages.

Damage — Blister beetles may move into the fields in swarms and strip plants or their leaves in a very short time. The beetles bite pieces out of the foliage giving the plants a ragged appearance. The amount of damage depends on the stage of growth of the plants at the time of attack and the size of the swarm of beetles.

Description and Life History — The eggs are yellow, elongate, more or less cylindrical, and are found in the soil. The larvae change considerably in form and appearance as they develop. When hatched, they are active with relatively long legs that become shorter with each succeeding stage. The last larval stage is yellow, tough-skinned, about 13 mm long, and with mouthparts and legs greatly reduced. The pupa is white to yellowish white and is found in the ground. The adults vary from 12-25 mm in length. The adult body is slender and the head is broad and quite distinct from the rest of the body. The color varies from metallic black or bluish purple to grey or brown and some adults have spots or stripes.

The female beetle deposits her eggs in little pockets dug in the ground during late summer. The eggs hatch in 2-3 weeks and the small active larvae feed mostly on grasshopper and cricket eggs. In spring, the larvae are transformed into pupae and, in June, the adult beetles emerge from the soil. Normally, there is only one generation per year in Alberta.

Control — When blister beetles attack, control measures must be prompt and thorough. The beetles are usually only a problem in years of grasshopper outbreaks. Recommended insecticides give good control of this insect.

White Grubs (Figures 104 and 105)

White grubs are the larvae of June beetles. The common species are mainly in the genera *Phyllophaga* and *Polyphylla.* These insects are only occasionally of serious economic importance on forages.

Damage — The larvae feed on the roots of many plants, especially grasses, and are most plentiful on light soils. Alfalfa and other crops may be damaged on newly broken grassland.

Description and Life History — The full-grown greyish white larvae are over 25 mm long, have three pair of prominent legs, and are always bent in a C-shape. The larvae do not mature for 3 years. They pass the first and second winter just below the frost line. In the third summer, the larvae pupate in the soil and the emerging adults remain inactive below the soil surface where they overwinter until the next May or June.

The June beetles are large brown or striped beetles that feed at night on trees. The beetles lay their pearly white eggs in soil. The eggs hatch in 2-3 weeks.

Control — White grubs are attacked by a wide range of predators including: insects, nematodes, fungi, birds, moles, and skunks. Where crops are being damaged severely, use a recommended soil insecticide.

Blue Alfalfa Aphid (Figures 106 and 107)

A new pest of forages from Asia has invaded the U.S.A., Mexico, Argentina, New Zealand, and Australia since 1974. The pest is the blue alfalfa aphid, *Acyrthosiphon kondoi* Shinji. In North America, the aphid was first discovered in California in 1974. Since then it has spread and is now established in Arizona, Idaho, Kansas, Nebraska, Nevada, New Mexico, Oklahoma, Texas, Utah, and Washington. It is a potential pest for Canada.

The blue alfalfa aphid is now in two states bordering Canada. The spread of this aphid will be closely watched

as it is expected to reach Alberta in the next few years. The aphid could seriously damage forages in the province and become the limiting factor in the production of some of these crops.

Damage — The aphid feeds mostly near terminals of plants. As the population increases, entire stems may become completely infested. The plants are usually damaged within 1-10 days after initial infestation.

It is believed that the species injects a toxin into the plant when feeding, which causes severe yellowing and stunting of the entire plant and eventually causes the death of many plants. Plants that do survive take several weeks to recover fully from the effects of the feeding. The aphid, if unchecked, has the potential of destroying as much as 50% of an alfalfa crop.

Description and Life History — The blue alfalfa aphid is similar in habit and appearance to the pea aphid, but is smaller and blue-green. Cool weather favors its development. Winged forms develop rapidly after the population becomes crowded on alfalfa and this may occur within 10 days after initial infestation; then the insects disperse widely in alfalfa fields.

The life cycle and host range of the aphid are not well known. Recent studies in Arizona show that the aphid prefers other species of legumes to alfalfa. Preferred hosts are yellow sweet-clover *Melilotus officinalis,* bird's-foot trefoil *(Lotus corniculatus),* and *Caragana arborescens,* but alfalfa is readily attacked.

Control — The aphid can be controlled by many of the same chemicals that control the pea aphid. Some varieties of alfalfa from southwestern U.S.A. are partially resistant to the blue alfalfa aphid.

Predators, Parasites, and Diseases

Several insects help keep the pest insects of forage crops under control. Most of the predatory and parasitic insects of the primary pests have been identified and some information on their life histories is available from the U.S.A. but, until recently, little was known about their life histories in Western Canada.

Predators need to feed on several individual insects to complete their development. They are usually active throughout their entire feeding period and are generally only partially selective in their food habits. Besides insects, many other invertebrates and vertebrates may be predacious on pest insects.

Parasites generally complete their development in or on one individual. Usually the larvae are parasitic but the adults are not. The adult deposits its eggs, in, on, or near the host. Once the larva starts its life as a parasite, it seldom moves to a new insect host. Some parasites attack only one species of insect but many can complete development in closely related species.

Predators, parasites, and diseases are very important for helping control pest insects. When insect populations are undisturbed by man, beneficial insects, disease organisms, and unfavorable weather may destroy 50-90% of a potential pest population. When pest species are controlled with chemicals, many predators and parasites of the pest species in a crop may be destroyed.

In forage production, we try to manage pests by means of integrated control. This is the synchronization of biological, chemical, and cultural control to reduce damage from pests and assure favorable economic and environmental results.

Agriculturists should learn to recognize the major beneficial insects associated with forage production. The more important beneficial insects of forage crops in Alberta are described and illustrated on the following pages.

Predators

Ladybird Beetles (Figures 108 and 109; 126-128)

Ladybird beetles, also known as lady bugs, are one of the most readily recognized beneficial insects. The common ones can be readily identified as the adults are usually red, orange, or yellow with various arrangements of black spots or black with white, red, or yellow spots. The most common ladybird beetles are in the genera *Coccinella, Hippodamia,* and *Adalia.*

The larvae are slightly flattened, taper to a point at the rear, and resemble small alligators. They are generally about 10 mm long when fully grown, are blue, black, or grey, with bright colored spots, and have warts and spines. When the larva is ready to pupate, it fastens itself by its "tail" to any convenient object and the skin splits down the back to reveal the pupa. The pupae are black and orange and are tear-drop shaped. They are usually found on surfaces such as leaves, stems, fence posts, and lumps of soil.

More than a dozen species of ladybird beetles are found in forage fields in Alberta. They can be important in keeping populations of aphids below injurious levels. Although most species have a preference for aphids, they will eat many other insects and mites when aphids are scarce. Each adult or full-grown larva of ladybird beetles consumes about 25 aphids/day. The consumption level depends on the size of the aphids. The beetles overwinter as adults and move into forage fields as soon as aphid populations begin to increase. One female may lay several hundred eggs over a lifetime that extends for several months. One species of ladybird beetle migrates from forage fields to areas in the foothills and mountains during the fall. Others remain near forage fields throughout the winter. In spring, they disperse over a wide area before starting to lay eggs. Because of this tendency to disperse, there seems to be little value of collecting adult beetles at hibernation sites for release in forage fields.

Damsel Bugs (Figure 117)

Damsel bugs are slender true bugs with grasping front legs. The adults are about 8 mm long and are greyish brown. The nymphs and adults are general feeders and readily eat aphids, lygus bugs, leafhoppers, small caterpillars, small alfalfa weevil larvae, springtails, and other insects. Damsel bugs are considered to be one of the most important predators of pea aphids and the most important predator of lygus bugs.

Adults overwinter in forage fields or along field margins. Although they can be readily found in fields in early spring and summer, they do not become numerous until late July and continue to be common until late fall.

Minute Pirate Bug (Figures 118 and 119)

The minute pirate bug, *Orius tristicolor* White, is about 0.5-1.5 mm long, which make them one of the smallest predatory insects in forage crops. The adults are flat and checkered black and white. The nymphs resemble the adults but are yellow to reddish orange. The eggs are small, white or clear, and are inserted into stems and petioles of such plants as alfalfa.

Pirate bugs overwinter as adults in sheltered areas in or near fields. The bugs, which are widely distributed, are present early in the spring in forage fields and become very common in alfalfa during July and August, especially when the crop is blooming. They are predacious on aphids, mites, thrips, leafhoppers, and on eggs, newly hatched caterpillars, and the immature stages of other small insects. Their host range is restricted by size. Sometimes these insects will bite humans. As they do not need blood for oviposition, they probably bite as a defence mechanism.

Green Lacewings (Figures 110-112; 124 and 125)

The adult green lacewings are easily recognized because they are green or yellowish green insects with two large pairs of delicate lace-like wings with a wing spread of over 30 mm. These insects are sometimes called golden-eye flies because of the peculiar metallic gold or copper color of their eyes. Some species have been called stink flies because they emit an offensive odor. The adults are often attracted to lights at night.

The larvae of lacewings, which are sometimes called aphid lions, are somewhat similar in size and shape to ladybird beetle larvae but are flatter, smaller, and usually brown, light yellow, and white. They have a tough, elastic and usually spiny skin and large sickle-shaped jaws that are hollow and serve as sucking tubes. Instead of consuming their hosts entirely, as the ladybird beetles do, they pierce the victims and suck out the fluids.

When fully grown, the larvae spin oval or spherical, smooth, closely woven cocoons composed of dense layers of silk which are deposited on the lower side of leaves or stalks.

Green lacewings lay their eggs on slender stalks about 7 mm long, singly or in groups, on the underside of leaves. Upon hatching, the larvae immediately seek food.

Some green lacewing adults feed on nectar, pollen, or honey dew but the green lacewing most common in Alberta feeds on aphids and other small insects. The larvae are more important predators than the adults. They feed on a wide variety of prey such as aphids, leafhoppers, mites, small spiders, and larvae of moths, butterflies, and beetles.

Hover Flies (Figures 113-115)

There are many species of syrphid or hover flies in Alberta. The adults resemble small bees or wasps with black and white or black and yellow striped abdomens. The flies hover almost motionless, then dart away suddenly for a short distance, then resume their hovering. The adults are not predatory but feed on honey dew, plant nectar, and pollen. They are pollinators of some plants but their value as forage pollinators appears to be slight.

The larvae vary in color from brown to yellow or green with white or mottled areas. They are somewhat flattened, pointed anteriorly, and fleshy. The green larvae may be mistaken for alfalfa weevil larvae but lack the black head capsule. The larvae of many species are predators and some are extremely important in the control of aphids on alfalfa.

The larvae pupate in fall and overwinter on foliage, debris, or in the soil. The pupae are enclosed in the last larval skin and are shortened, brown, and oval or somewhat pear-shaped. Eggs are usually oval, white with a pebbled surface, and are usually laid singly among aphid colonies.

Big-eyed Bugs (Figure 116)

Big-eyed bugs are easily identified because they are about 3-5 mm long, shaped like a lygus bug but slightly smaller, and have large bulbous eyes that are present in both the adult and nymphal stage. They are dark greyish brown and are sometimes confused with lygus bugs or false chinch bugs.

Big-eyed bugs feed on many small insects and mites and are important predators of aphids, plant bugs, and leafhoppers. Both adult and nymphal big-eyed bugs are predacious on lygus but the smaller nymphs prefer to feed on aphids. They frequently attack insect eggs in preference to the active stages. When mites or aphids are numerous, the big-eyed bugs concentrate their feeding on them.

Other Predators in Forage Crops (Figure 120)

Several other predators are found in alfalfa fields. The larvae of chloropid flies feed on small insects such as aphids. Robber flies feed as adults on grasshoppers, bees, and a wide variety of other insects.

Several beetles are also predatory. The adult *Collops* beetle is a general feeder on small insects. Blister beetles are often found in alfalfa and may be beneficial or harmful depending on the species. Some larvae feed on grasshopper eggs and others destroy ground-nesting bees. Most adults are damaging as they feed on foliage. Ground beetles also prey on pests of alfalfa.

Ambush bugs and assassin bugs are general feeders and although they may destroy both pests and beneficial insects, they can be important in the control of plant bugs. Dragonflies prey on small flying insects. Several species of mites and one species of thrip destroy pest thrips and mites, and the eastern flower thrip feeds on alfalfa weevil eggs. Spiders are general feeders of insects in forage crops.

Besides eating pest insects, some predators may eat other members of their own species or other beneficial insects when the pest species are absent or present only in low numbers.

Parasites

Aphid Parasites (Figures 121 and 122)

The most common aphid parasites are tiny wasps. The female wasp punctures the skin of an aphid and lays a single egg in each aphid host. The larvae hatch and feed inside the aphids, consume the internal tissue and leave only the light brown hardened bodies called mummies. The larvae pupate in the mummies and emerge as adults through holes cut on the top of the abdomen. There are usually several generations per year. These parasites overwinter as mature larvae.

Three species of *Aphidius* parasites and one species of *Praon* are important for controlling pea aphids in Alberta. In the early 1970s, *Aphidius smithi* Sharma and Subba Rao, the most successful parasite of the pea aphid, was found in Alberta and B.C. This parasite was introduced into California and the eastern U.S.A. from India and is now dispersed throughout most of the U.S.A. and many parts of Canada.

Alfalfa Weevil Parasites

Much effort has been expended to release and establish exotic parasites of the alfalfa weevil in North America. The small ichneumonid wasp, *Bathyplectes curculionis* Thomson, was successfully introduced from Italy and Switzerland. It is an internal parasite of the weevil larva. Shortly after alfalfa weevils were first found in Alberta, the parasite was also found. It is one of the important factors aiding in the control of the alfalfa weevil in Alberta.

Parasites of Other Insects

Caterpillars such as the alfalfa looper, the alfalfa caterpillar, and the beet webworm may be controlled by braconid or ichneumonid wasps, or by tachinid flies. Grasshoppers may be controlled by sarcophagid flies.

In Alberta, some beneficial insects are attacked by parasites. The predatory western damsel bug, *Nabis alternatus* Parshley, is parasitized by a braconid wasp and a tachinid fly. The pea aphid parasites in the genus Aphidius are parasitized by two tiny wasps. Ladybird beetles in Alberta are sometimes parasitized by a braconid wasp.

Diseases (Figure 123)

Fungi, bacteria, and viruses often infect insects and destroy them. Pea aphids, grasshoppers, and alfalfa weevils are often killed by fungi in the genus *Entomophthora.* Alfalfa loopers and alfalfa caterpillars are frequently destroyed by virus diseases. The viruses are often specific. Disease organisms of a pest insect seldom attack its predators or parasites.

Pollinators (Figures 129 – 131)

In most forage fields, several species of bees are present. The most common form three groups: honey bees, which produce honey and pollinate such crops as sainfoin; bumble bees, which pollinate red clover and alfalfa; and leafcutter bees, which are the most important pollinators of alfalfa. These insects must be considered in integrated pest management programs.

FORAGE DISEASES

Introduction

A disease may be defined as an abnormal condition, and forage crops suffer from a multitude of them. The cause may be parasitic or nonparasitic. Parasitic diseases are caused by fungi, viruses, bacteria, mycoplasma, nematodes and occasionally higher plants. Nonparasitic diseases are caused by an unfavorable factor or factors in the environment, e.g., a nutrient deficiency, unfavorable acidity, high salts, unfavorable temperatures, etc. Symptoms are the expression of disease in plants, and are the reaction of the plant to the parasite or nonparasitic factor. A change in the color or form of the plant is often specific enough to be used in the visual identification of disease. To confirm the cause of disease the parasite must be isolated and the plant reinfected. A nonparasitic cause can usually be found by soil tests, in weather records or by investigating farm practices.

Parasites are generally controlled through their feeding habits. Many are specific to a certain family, genus, species, cultivar or part of a plant. A pathogen's specificity to cultivar is utilized in breeding for resistance which is our best tool in controlling plant diseases. Specificity to family, genus or species is widely utilized to control diseases through crop rotation.

Most parasites (pathogens) either infect the above-ground or below-ground portion of the plant, seldom both. Foliage pathogens are generally much more specific to host and generally less specialized than root pathogens.

Foliage pathogens can multiply and spread rapidly. They are usually spread by wind and can do a great deal of damage during a short period of time. Their activity is very dependent on weather conditions and a readily available supply of food. However, they are often relatively easy to control by cutting the forage crop fairly short, burning the previous years' diseased crop residue in the spring before growth resumes, or if these measures fail, by crop rotation or the use of a resistant cultivar.

Root pathogens are more difficult to control. They are usually native to the soil. The first defense against root diseases is to keep the crop as vigorous as possible through good agronomic practices such as seed inoculation, fungicide seed treatment, adequate fertilization and proper harvesting periods. When root pathogens become a problem as indicated by excessive winterkill and invasion of the crop by weeds, then the only control is to destroy the crop and to reduce the population of the root pathogens by growing resistant crops.

Diseases of Alfalfa

The order in which alfalfa diseases are discussed varies with the part of the plant attacked. Leaf diseases are presented first, followed by those of the stem, bud, crown and finally the root. Only diseases of significant economic importance are included.

Diseases generally become more severe with the age of the alfalfa stand. Except for alfalfa sickness, the crop is generally quite free of disease during the first year. Many diseases become established during the second year and by the fourth year the stand is beginning to thin and become invaded by weeds. It is often uneconomical to keep an alfalfa stand after the fourth year. Alfalfa grown for seed generally lasts longer than that grown for forage because a higher level of carbohydrates is maintained in the roots. Alfalfa grown on dry land is less prone to disease than that grown on irrigated land.

The best way to maintain the productivity of an alfalfa stand is to keep it as healthy as possible by good agronomic practices. Grow an adapted variety with good disease resistance. Inoculate the seed to ensure nitrogen fixation and treat it with a fungicide to control seedborne diseases. Avoid planting alfalfa on acidic soils and fertilize adequately.

Leaf diseases can best be controlled by cutting the crop fairly short before leaf-fall is excessive. Burning in the spring reduces the amount of infected crop debris; it must be done before growth begins to prevent crop injury.

To avoid excessive losses from crown and root diseases, fertilize adequately, allow the plants to recover in the spring before they are cut and allow growth in late summer to replenish root reserves for winter maintenance and vigorous spring growth. See crown bud rot.

Common Leaf Spot

(Pseudopeziza trifolii) (Figure 132)

Common leaf spot is a major foliage disease of alfalfa. It also infects sweet-clover but is less destructive. Crop losses occur through reduced photosynthesis and dropping of leaves. The disease is favored by cool wet weather.

Small brown to black, circular spots appear on the leaflets. In older spots a small raised disc, usually lighter in color, develops. This raised disc, the fruiting body of the fungus, distinguishes the disease from black stem. The fungus overwinters in infected leaves. In the spring the spores are discharged and are carried by the wind to new growth. Infection can occur throughout the summer.

The disease can be partially controlled by cutting before defoliation becomes severe. Rambler is resistant to common leaf spot.

Yellow Leaf Blotch

(Leptotrochila medicaginis) (Figure 133)

The disease is widespread but is confined to alfalfa. It is probably more destructive in northern than in southern areas.

The disease first appears as elongated yellow blotches that develop parallel to the viens on the lower leaves.

Older blotches become brownish-orange and develop linear patterns of dark dots in their centres. Spores from infected leaves do not mature until the following spring. Blotches appear occasionally on stems. The disease may cause severe defoliation. Forage losses up to 15% occur in individual fields.

Control yellow leaf blotch by cutting before leaf drop, by careful spring burning and by crop rotation. Rambler and Anik are resistant.

Black Stem
(Phoma medicaginis) (Figure 134)

Black stem is widespread on alfalfa. A very similar disease is found on sweet-clover and common clover. Black stem is favored by cool, moist weather.

In early summer small irregular dark-brown or black spots appear on the lower leaves, crown buds and small stems. Later flower stalks, pods and seeds may become infected. Severe spotting on the leaves causes them to turn yellow and drop off. Severe infection kills young stems. The fungus overwinters on seed, stems, crowns and crop debris. It does not persist for more than two years in soil in the absence of alfalfa.

Control by cutting before many leaves are destroyed or severely infected. Carefully burn infested debris in the spring. Burning after plant growth begins may cause plant injury. Rotate with nonlegume crops. Treat the seed with a fungicide to avoid seedborne infection. Beaver, Rambler, and Vernal are resistant cultivars.

Downy Mildew
(Peronospora trifoliorum) (Figure 135)

Downy mildew is widespread on alfalfa but rarely infects sweet-clover. It usually does not cause severe damage. The disease occurs in cool, wet, humid weather particularly during the spring period.

Light-green to yellow blotches appear on the leaves. The top part of the shoots are often dwarfed and the leaves twisted or rolled. Greyish fungal growth often occurs on the underside of the leaflets. The fungus grows through the whole plant and overwinters in the crown buds and dead leaves.

Control downy mildew by crop rotation and by using resistant cultivars. Algonquin, Anik, and Thor are resistant. Regrowth will usually escape damage if the diseased crop is cut fairly short during warm, dry weather.

Verticillium Wilt
(Verticillium albo atrum) (Figure 136)

This is the most destructive alfalfa disease in western Europe. It is well established in the northwestern United States (a major source of seed) and in the southern interior of British Columbia. A few isolated cases of the disease have been found in the irrigated area of southern Alberta.

The fungus impedes the flow of water from roots. The first symptom is a temporary wilting of upper leaves on warm days. This is followed by a general wilt and the leaves turn white or yellow. At first the stem remains green, later, starting at the base, the stem turns grey then black from the growth of fungal fruiting bodies. Infected stems may or may not be mixed with healthy stems. The outer vascular tissues within infected stems are stained brown.

The disease is spread into new areas by infected plant debris carried with the seed. Spread within a field is probably caused by machinery spreading infested plant debris and fungal spores.

In British Columbia, fields infected with verticillium wilt become unproductive during the fall of their third year. Infected plants are very susceptible to winterkilling. Infection is much more severe in irrigated areas or in areas with a high water table than in dryer areas.

Control verticillium wilt by using clean seed treated with a recommended fungicide. Plough under infested fields, grow immune crops such as grasses or cereals and eradicate volunteer alfalfa for at least 2 years. Use resistant cultivars when they become available.

Stem Nematode
(Ditylenchus dipsaci) (Figure 148)

The stem nematode is essentially restricted to alfalfa. The nematode or eelworm is an unsegmented worm less than 1 mm in length that is a minor cause of plant diseases in temperate regions of the world. Significant damage to alfalfa by the stem nematode is confined to older alfalfa stands in the irrigated districts of southern Alberta.

Nematodes invade crown buds which become swollen, brittle, deformed and may fail to develop stems. Stems from infected buds are severely dwarfed with thickened nodes, shortened internodes, and tissues that are wrinkled and discolored. Occasionally, white shoots appear.

The stem nematode can carry wilt bacteria to cultivars that are both susceptible and normally resistant to bacterial wilt.

Control stem nematode by maintaining plant vigor and limiting stand life to four years. The cultivar Trek is resistant.

Winter Crown Rot or Snow Mold
(Coprinus sp. (formerly LTB) and *Fusarium nivale)* (Figures 137 and 138)

The disease is widespread and is sometimes very destructive in central and northern areas. All legume and grass forage crops are susceptible.

The fungi cause a dark-brown rot of the crown tissue under the snow during the winter and early spring. *Coprinus* is active only at near-freezing temperatures whereas, *F. nivale* can become active as soon as the plants are dormant. These snow molds usually cause irregular patches of dead plants in the spring. However, the plants may just be severely weakened if the crown buds and only a small portion of the crown is rotted. In either case the main root is usually quite healthy.

Control winter crown rot by planting the most winter hardy cultivars with low or underground crowns and by maintaining plant vigor. Anik and other cultivars with *M. falcata* parentage are more resistant than those from *M. sativa.*

Crown Bud Rot
(Rhizoctonia solani, Fusarium roseum, Phoma medicaginis) (Figure 139)

Crown bud rot is common in alfalfa after the first season in irrigated or moist soils. The disease spreads most rapidly during the early part of the growing season. There is a progressive decline in stand and yield as plants become partially devoid of crown buds and stems. The stand becomes thin and is readily invaded by weeds.

Dark brown or black patches develop on the bud tissue and spread to the crown and upper root areas. The fungi attack buds directly and later invade crown tissues. Roots generally require wounding for the fungi to penetrate. Wounds may be caused by insects, winter injury or mechanical injury. The fungi overwinter in diseased crowns and roots or in the soil.

Control crown bud root by maintaining plant vigor. Fertilize adquately. Allow plants to recover in the spring before cutting. Allow about 25 cm of growth before the end of the growing season to replenish root reserves. This growth may be harvested after the plants become dormant. Rotate with resistant crops, such as cereals for 2 or 3 years to reduce the population of the causal fungi. Avoid maintaining nonproductive alfalfa stands. The following cultivars have some resistance to crown bud rot: Anchor, Beaver, Drylander, Roamer, Thor and Trek.

Bacterial Wilt
(Corynebacterium insidiosum) (Figure 147)

Bacterial wilt only affects alfalfa. It is most common in irrigated areas but may be found elsewhere if moisture is abundant. Although the disease was very destructive it is now controlled with resistant cultivars.

The first symptoms appear in the roots where a yellowish orange to light brown ring develops in the woody layer immediately beneath the surface of the main roots. This discoloration eventually spreads throughout the woody root. By the second or third year infected plants are stunted, yellowed, have small-cupped leaves and wilt during warm weather. Severely infected plants rarely survive the winter.

The bacteria overwinter mainly in diseased alfalfa roots and in plant remains in the soil. They are carried by soil water and enter plants through wounds produced by winter injury, insects or mechanical damage.

Control bacterial wilt by growing alfalfa for not more than 4 consecutive years and following it with another crop for at least 2 years. Always clean and disinfest mowers between infested and uninfested fields. Control bacterial wilt by growing one of the following resistant cultivars: Anchor, Beaver, Drylander, Kane, Roamer, Thor, Trek and Vernal.

Alfalfa Sickness
(cause unknown)

A nematode, a fungus and two bacteria have been implicated as causal agents. The disease is confined to alfalfa and occurs in central Alberta. Alfalfa sickness describes the condition that occurs when alfalfa does not grow well on land previously cropped to alfalfa. Germination is usually good but seedlings are stunted, spindly, yellowed and poorly nodulated.

The only control is to avoid growing alfalfa on land where the condition is known to exist. Cultivars resistant to alfalfa sickness are being developed.

Brown Root Rot
(Plenodomus meliloti)

See sweet-clover.

Diseases of Sweet-Clover

Black Stem
(Phoma trifolii)

See Red clover.

Brown Root Rot
(Plenodomus meliloti) (Figure 149)

Brown root rot is most severe on sweet-clover, but it also affects alfalfa, red clover, alsike clover and bird's-foot trefoil.

The disease is identified by yellow stunted plants which occur in the spring and sometimes die after beginning growth. Circular light to dark brown dead areas rot through the roots and eventually spread into the crown. Small black balls form on the dead roots.

The cultivar Yukon is resistant.

Common Leaf Spot
(Pseudopeziza meliloti)

See alfalfa.

Gray Stem Canker
(Ascochyta caulicola)

The disease is widespread but usually causes little damage.

The name of the disease is derived from the silvery-white cankers that form on the stems, leaf stalks and midribs of leaves. Large cankers may girdle the lower part of stems. Small dark-brown dots, the fruiting body of the fungus, form on the centre of the cankers. Heavily infected stems twist and bend at the top, appear swollen, are retarded in development and have fewer and smaller

leaves. Floral infection results in diseased seed.

Control gray stem canker by crop rotation, cut fields cleanly and harvest fence rows and ditches. The cultivar Yukon is resistant. No fungicides are registered to control the disease on seed.

Diseases of Red Clover

Black Stem
(Phoma trifolii)

Black stem also infects sweet-clover and alsike clover. The disease is very similar to black stem of alfalfa. Cool, moist weather favors the disease, so spread is apt to be most extensive during the spring and fall.

Black or dark brown areas develop on stems, leaves and pods. Heavily infected plants may drop their leaves and pods.

Control black stem by rotating with nonlegume crops, by burning in the spring before growth begins and by cutting hay early and close to the ground.

Brown Root Rot
(Plenodomus meliloti)

See sweet-clover.

Northern Anthracnose
(Kabatiella caulivora) (Figure 140)

The disease has been very destructive to red clover in central and northern Alberta. Alsike and white clover are fairly resistant. Cool, humid weather favors disease development.

Early symptoms are water-soaked areas on the stems and petioles. These lesions enlarge and become dark brown; later their centres dry, become sunken and turn a lighter brown. Plant parts above the infected area wilt and die. Flower heads are often broken off by the wind. Stems and petioles usually curve to give the appearance of a shepherd's crook. Cracking of stem tissue is sometimes pronounced. The fungus overwinters on stubble and produces masses of white to pinkish spores in old lesions in the spring. The spores are spread by rain and to a lesser extent by insects. The disease is slightly seedborne, but not soilborne. Disease development is favored by cool wet weather.

Control northern anthracnose by crop rotation. The cultivar Norlac is resistant.

Powdery Mildew
(Erysiphe polygoni) (Figure 141)

Powdery mildew is a serious disease of both red and alsike clover. Severe epidemics reduce the quality of hay and the yield of hay and seed.

The disease is easily recognized by a light-grey powdery layer of the fungus on the upper surface of leaves. The leaves become yellow and later brown if infection is severe. The fungus overwinters on foliage and crop debris.

No practical control measure is known.

Sooty Blotch
(Cymadothea trifolii)

See alsike clover.

Winter Crown Rot
(Coprinus sp. (formerly LTB) and *Fusarium nivale)*

See alfalfa.

Diseases of Alsike Clover

Black Stem
(Phoma trifolii)

See red clover.

Brown Root Rot
(Plenodomus meliloti)

See sweet-clover.

Powdery Mildew
(Erysiphe polygoni)

See red clover.

Sooty Blotch
(Cymadothea trifolii) (Figure 142)

Sooty blotch is common on alsike and white clovers, but rarely appears on red clover. Severe infections reduce seed yields.

Conspicuous dark-brown to black pustules form on the underside of the leaves. Leaves may shrivel and die. Severe destruction of foliage and prevention of flowering can occur during cool moist conditions. Infected foliage is toxic to livestock and may cause mouth ulcers.

Control sooty blotch by rotating with nonlegumes for 3 years, clean cutting and stubble burning.

Winter Crown Rot
(Coprinus sp. (formerly LTB) and *Fusarium nivale)*

See alfalfa.

Diseases of Brome Grass

Brown Leaf Spot
(Leaf Blotch)*(Pyrenophora bromi)* (Figure 146)

Brown leaf spot is very common but not usually severe. The disease is favored by humid weather and poor nutrition.

Elongated brown spots appear on young leaves early in the spring. Later the spots enlarge and develop a yellow halo. Leaves wither and die from the tips downwards. Spots also occur on stems.

Control consists of clean grazing or cutting, stubble burning after harvest and maintaining soil fertility. Cultivars Baylor and Magna have intermediate resistance to brown leaf spot.

Selenophoma Leaf Spot
(Selenophoma bromigena) (Figure 150)

Selenophoma leaf spot is widespread, but occurs only on brome grass. It is not usually severe except under prolonged humid weather.

Brown spots occur on leaves, leaf sheaths, stems and floral parts. In the early stages these spots are similar to those of brown leaf spot. However, mature spots have dark-brown borders and pale centres which contain black dots. Severely affected leaves wither from the tip downward. Spores are released in the spring and are spread by wind and rain.

Control consists of crop rotation, clean grazing or cutting and stubble burning. The cultivar Magna has intermediate resistance to selenophoma leaf spot.

Snow Molds
(Sclerotinia borealis) (mainly), *Typhula spp., Coprinus sp.* (formerly LTB), *Fusarium nivale* and *Plenodomus meliloti)*

See fescue.

Diseases of Fescue

Snow Molds
(Sclerotinia borealis) (mainly), *Typhula spp., Coprinus sp.* (formerly LTB), *Fusarium nivale* and *Plenodomus meliloti)* (Figure 143)

Fungal growth is usually present on dead patches of grass when growth resumes in the spring. Small black sclerotial bodies are often enclosed in leaf sheaths of dead plants. Resistance to snow molds depends on the vigor and food reserves of the plant, and on the depth and duration of snow cover.

Control by removing debris of the previous crop and by applying enough nitrogen late in the fall to bring the total up to 50-70 kg N/ha for first crops and 70-100 kg N/ha for subsequent and rejuvenated crops. Rotate fescue with spring-sown crops such as rape or a cereal.

Stem Eyespot
(Didymella festucae) (Figure 151)

Stem eyespot is confined to fescue grasses. It affects seed production only, not turf or forage. The fungus requires stems before it can significantly invade a field. Consequently it seldom invades the first crop sufficiently to cause significant losses.

The disease is characterized by the development of brown to purple-brown spots, often with light centres, that develop on the flowering stems. Spots also occur on the leaf sheath, flower parts and seeds. Leaf spots are rare. Seed does not develop. Maximum seed production can be achieved in the first year by using high seeding rates (6-10 kg/ha) and by applying sufficient nitrogen late in the fall to bring the total up to 50-70 kg/ha.

Direct control can be achieved when rejuvenating a stand by using a hot burn to remove all debris and stubble, followed by plowing immediately after harvest. Hot burning harms the flower buds and prevents seed production and therefore should be used only as a part of rejuvenation.

Diseases of Timothy

Purple Spot
(Heterosporium phlei) (Figure 144)

Purple spot is widespread but is rarely severe. Cool humid weather favors disease development. Severe infections will impair hay quality and reduce seed yields.

Purple-brown oval spots with light greyish-brown centres develop on the leaves. Severely affected leaves wither and die from the tip downwards.

Control purple spot by ensuring nitrogen and phosphorus fertility is adequate. The disease is more severe when fertility is low. Burning the stubble may severely damage the stand but will partially control the disease. North American cultivars have more resistance than those from elsewhere. Bounty and Climax have intermediate resistance to purple spot.

Leaf Streak
(Drechslera phlei) (Figure 145)

Leaf streak is rarely very destructive in Alberta. However, the disease is seedborne and may be destructive in moister climates where the seed is used.

Indeterminate longitudinal light brown streaks occur on the leaves often along the margins. Later the leaves wither and die from the tips downward causing a loss of hay quality and, in severe cases, seed yield.

Control consists of crop rotation, clean grazing or cutting, stubble burning and maintaining soil fertility. None of the recommended cultivars is resistant.

Snow Molds
(Sclerotinia borealis) (mainly), *Typhula spp.*, *Coprinus sp.* (formerly LTB), *Fusarium nivale* and *Plenodomus meliloti)*

See fescue.

CONVERSION FACTORS FOR METRIC SYSTEM

Imperial units	Approximate conversion factor	Results in:	
LINEAR			
inch	× 25	millimetre	(mm)
foot	× 30	centimetre	(cm)
yard	× 0.9	metre	(m)
mile	× 1.6	kilometre	(km)
AREA			
square inch	× 6.5	square centimetre	(cm^2)
square foot	× 0.09	square metre	(m^2)
acre	× 0.40	hectare	(ha)
VOLUME			
cubic inch	× 16	cubic centimetre	(cm^3)
cubic foot	× 28	cubic decimetre	(dm^3)
cubic yard	× 0.8	cubic metre	(m^3)
fluid ounce	× 28	millilitre	(ml)
pint	× 0.57	litre	(ℓ)
quart	× 1.1	litre	(ℓ)
gallon	× 4.5	litre	(ℓ)
bushel	× 0.36	hectolitre	(hl)
WEIGHT			
ounce	× 28	gram	(g)
pound	× 0.45	kilogram	(kg)
short ton (2000 lb)	× 0.9	tonne	(t)
TEMPERATURE			
degrees Fahrenheit	(°F-32) × 0.56 or (°F-32) × 5/9	degrees Celsius	(°C)
PRESSURE			
pounds per square inch	× 6.9	kilopascal	(kPa)
POWER			
horsepower	× 746	watt	(W)
	× 0.75	kilowatt	(kW)
SPEED			
feet per second	× 0.30	metres per second	(m/s)
miles per hour	× 1.6	kilometres per hour	(km/h)
AGRICULTURE			
gallons per acre	× 11.23	litres per hectare	(ℓ/ha)
quarts per acre	× 2.8	litres per hectare	(ℓ/ha)
pints per acre	× 1.4	litres per hectare	(ℓ/ha)
fluid ounces per acre	× 70	millilitres per hectare	(ml/ha)
tons per acre	× 2.24	tonnes per hectare	(t/ha)
pounds per acre	× 1.12	kilograms per hectare	(kg/ha)
ounces per acre	× 70	grams per hectare	(g/ha)
plants per acre	× 2.47	plants per hectare	(plants/ha)